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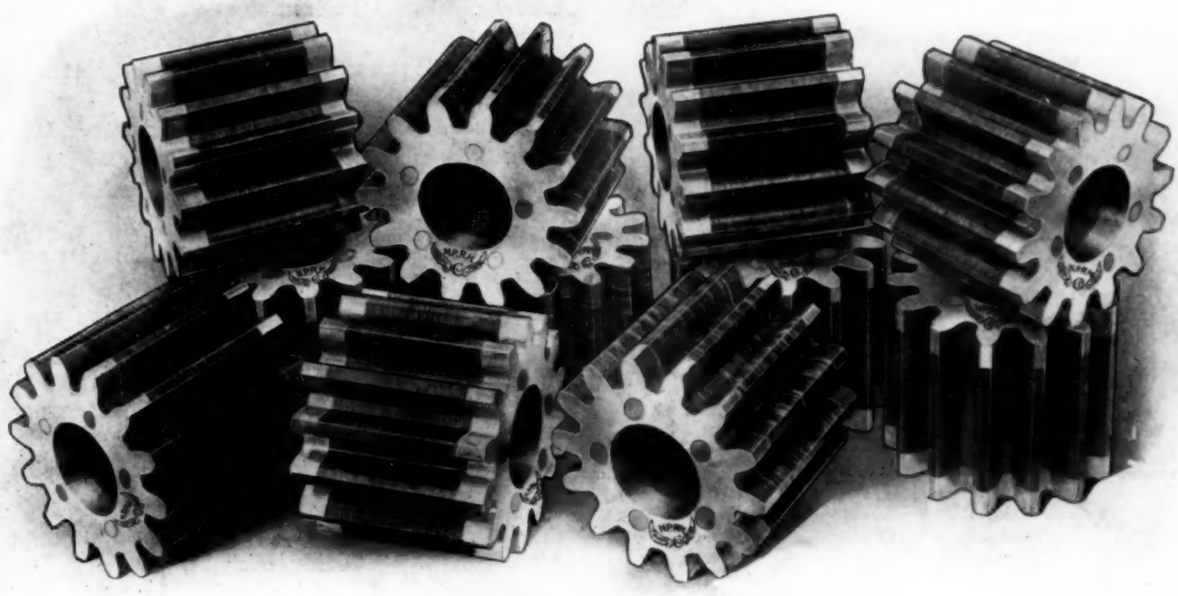

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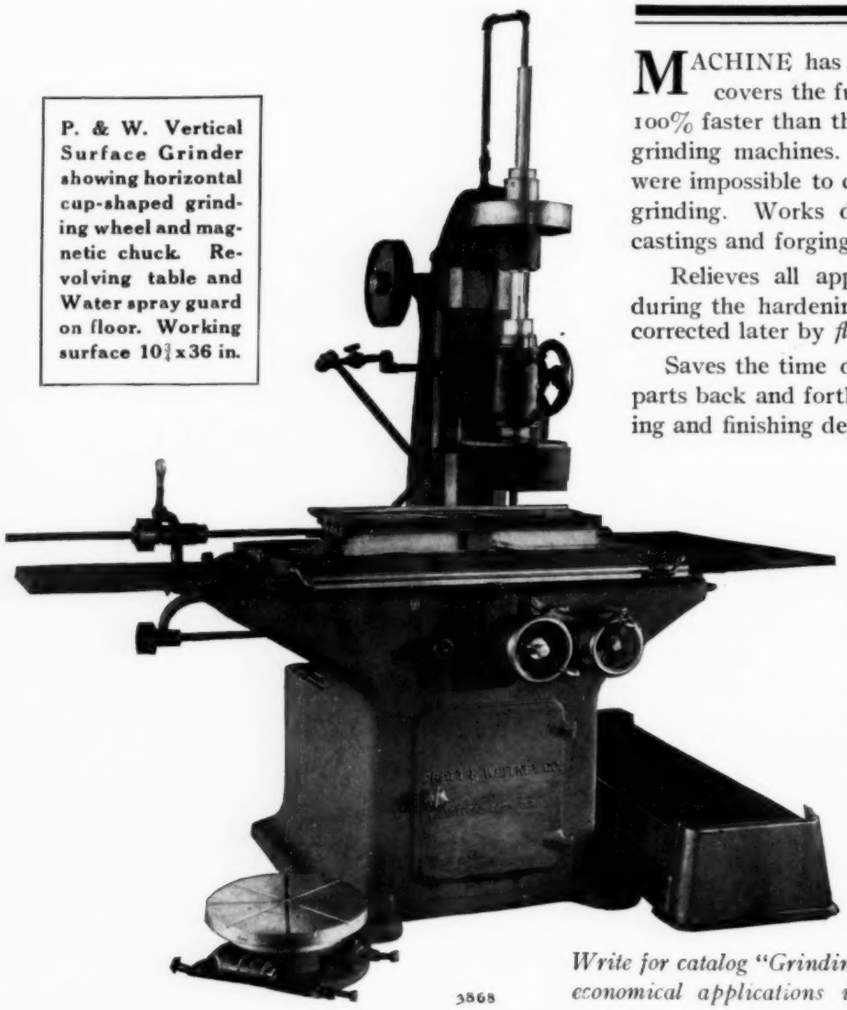

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(*See pages 47 and 48*)

High-speed Steel Drill Tests

By E. R. Norris *

Extensive comparative tests of twisted, milled fluted and forged fluted high-speed steel drills. Three distinct tests were made; an endurance test in cast iron, an endurance test in steel and a breakdown test in steel. It was found that more power was required to drive flat twisted drills than milled drills. The tungsten content does not seem to influence the efficiency of the drill in proportion to its amount.

*Assistant manager of works, Westinghouse Electric and Manufacturing Company.

Drills made of high-speed steel when first put on the market had no difficulty in meeting the requirements of the drill presses then in use, but since the introduction of the heavy-duty and high-speed drilling machines, this condition has changed, and the manufacturers of high-speed drills are now keen to the necessity of furnishing drills which will give the best service at a reasonable cost.

The radial drill, Fig. 1, was used in the following described tests on several makes and styles of drills conducted at the works of the Westinghouse Electric and Manufacturing Company. This machine was designed for heavy service and high speeds and ample power was furnished by means of a Westinghouse 12½-horsepower type S adjustable-speed 1 to 4 motor. The motor is mounted on the top of the column, making the machine entirely self contained. The method of mounting the controller on the spindle saddle makes it convenient for the operator to start, stop, reverse and vary the spindle speeds, regardless of the position of the spindle saddle on the arm. All the gears are made of steel. One change gear and a 16-notch controller give 32 spindle speeds varying from 30 to 500 revolutions per minute.

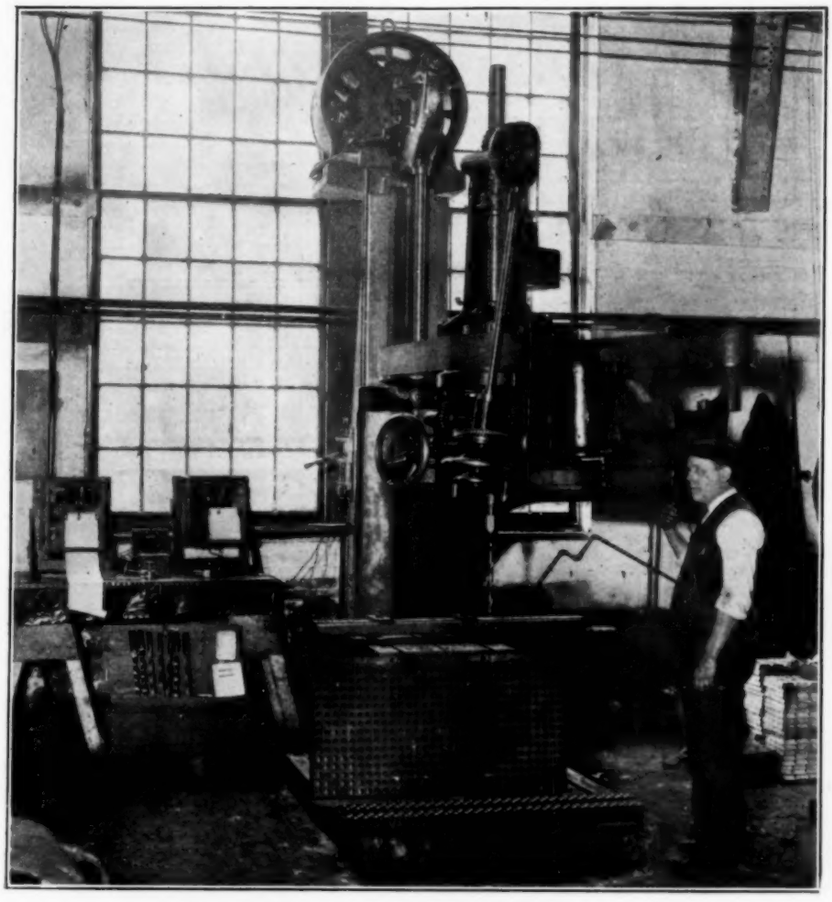

FIG. 1. RADIAL DRILL USED IN DRILLING TESTS

Often, high-speed drills are condemned on account of breakage when the trouble should be charged rightly to the drill press used. Drill presses having lost motion in the spindle or constructed too weak to resist the pressure of the drill against the work will often cause the drill to break, due to the sudden release of this pressure after the point of drill breaks through the work. The two small taper chips shown in Fig. 2 are chips made just as the full diameter of the drill is cutting through the work, and clearly show that the drills used in this test carried the feed only.

THE DRILLS TESTED

Complete tests were made with the flat twisted, milled and forged flute drills, representing the product of several manufacturers. All drills were 1 1/32 inches in diameter and 16 inches long over all. This size and length was selected on account of its general use on certain classes of work. As far as possible all trade marks that would lead to the identity of the drills were destroyed and each make of drill was symbolized, and the records of performance were recorded by symbol, thus it was not known what make of drill was being tested by those making the test, as the key to the symbols was not consulted until the tests were completed.

Three distinctive tests were made; namely, an endurance test in cast iron, an endurance test in steel and, finally, a break-down test in steel. Cast iron and steel slabs of uniform thickness and material were used; the cast iron was 3½ inches thick and the steel 2 inches thick. Some of the slabs can be seen in Fig. 1.

FIG. 2. CHIPS MADE BY DRILL WHEN BREAKING THROUGH

CHEMICAL ANALYSIS OF MATERIAL USED

The chemical analysis of the cast iron is: Graphite carbon, 2.60; combined carbon, 0.32; silicon, 2.06; sulphur, 0.092; phosphorus, 0.58; manganese, 0.53. The chemical analysis of the steel is: Carbon, 0.16; silicon, trace; sulphur, 0.056; phosphorus, 0.016; manganese, 0.46.

As the power consumed to drive the drills is an important factor in a test of this kind, two Westinghouse graphic recording meters were used, as shown in Fig. 1, the meter on the right recording

amperes, the one on the left recording volts. The curves made by the meters will be described later.

Specimen Drill Tests

The first test was made in cast iron and each drill was started at the same feed and speed and gradually increasing them until the drill required grinding.

Great care was taken in determining this point, drills being inspected after every two holes drilled.

Fig. 3 shows the method of recording the test, also results obtained with one of the drills in cast iron. It will be noted that 49 holes were drilled through 3½-inch material, or a total of 171½ inches in an actual drilling time of 13 minutes, averaging ¼ minute per hole and removing 11 cubic inches of material per minute or a total of 143 cubic inches. The drill was not ground during this time and by slight grinding the drill would be in good condition for further work.

Fig. 4 shows the ammeter reading for this drill and it will be noted that curves run in series of two and then drop to zero, thus showing the length of time required to inspect the cutting edges. The shop circuit varied between 240 and 260 volts, due to intermittent loads.

Fig. 5 shows results obtained with the drills on the endurance and break-down test in steel. On the endurance test, the feeds and speeds were gradually increased until the cutting edges started to wear, this point is indicated by a heavy line across the figure. The same drills were then used without grinding on the break-down test, and drilling was continued until the drill burned or broke, as indicated below the heavy line.

Fig. 6 shows the ammeter reading for this test. Several break-down tests were made on cast iron by running the machine at its maximum feed and speed, which is 500 revolutions per minute and 0.08 inch feed per revolution, which is equivalent to a feed of 40 inches per minute, but due to slippage and friction an actual drilling feed of 36 inches per minute is all that could be maintained. At this speed several tests were made drilling 3½-inch cast iron with 1 1/32-inch drills, and while the drills did not break, they were all badly burned making it necessary to cut off a considerable length on the end before regrinding. As high as 10 holes were drilled at this speed by the same drill without grinding. During this test, 30 to 40 horsepower was consumed, taxing the motor with over 200 per cent. overload, and no trouble was experienced, thus showing that the motor will stand intermittent loads considerably above its normal rating.

The records show that more power was consumed in driving the flat-twisted drills than the milled drills. This is probably due to the natural lip on the cutting edge of the milled flute drill, thus allowing the drill to cut freer.

Size Drill 1 1/32 Machine _____ Mach. No. _____
Tested on _____ Dwg. No. _____ Hem. No. _____ Sec. _____

Test No.	Make of Drill	Horsepower Average			Style	Material	Revolutions per Min.	Feed per Rev.	Feed per Min.	Cutting Speed in Feet per Minute	Number of Holes Drills	Thickness of Material Drilled	Condition of Drill.
		Total	Friction	Net									
1		6.40	3.81	2.59		C.I.	340	0.025	8½	92	8	3½"	Good.
2		9.20	3.81	5.39		C.I.	305	0.045	13⅞	82½	30	3½"	Good.
3		11.50	4.19	7.31		C.I.	380	0.045	17	103	4	3½"	Fair. Cutting edges slightly worn.
4		13.90	5.23	8.67		C.I.	445	0.045	20	120	7	3½"	Requires Grinding.

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Fig. 3. Report of Drill Test in Cast Iron

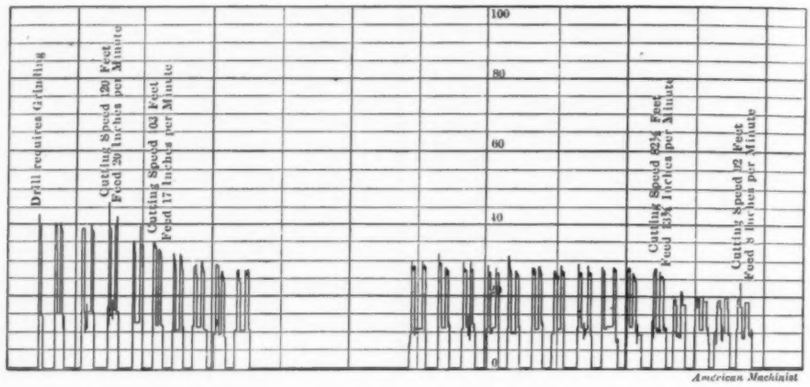
Drill requires Grinding
Cutting Speed 120 Feet. Feed 20 Inches per Minute
Cutting Speed 100 Feet. Feed 17 Inches per Minute
Cutting Speed 82½ Feet. Feed 13¾ Inches per Minute
Cutting Speed 72 Feet. Feed 8 Inches per Minute
100
80
60
40
0
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Fig. 4. Ammeter Diagram Corresponding with Report of Fig. 3

Size Drill 1 1/32 Machine _____ Mach. No. _____
Tested on _____ Dwg. No. _____ Hem. No. _____ Sec. _____

Test No.	Make of Drill	Horsepower			Style	Material	Revolutions per Min.	Feed per Rev.	Feed per Min.	Cutting Speed in Feet per Minute	Number of Holes Drills	Thickness of Material Drilled	Condition of Drill.
		Total	Friction	Net									
1		6.83	2.39	4.44		Steel	320	0.015	4¾	86	6	2"	Good
2		7.66	2.66	5.00			340	0.015	5⅛	92	6	2"	"
3		8.70	3.01	5.69			370	0.015	5½	100	6	2"	"
4		9.55	3.24	6.31			415	0.015	6¼	112	6	2"	"
5		10.56	3.58	6.98			465	0.015	7	125	6	2"	"
6		11.55	3.72	7.83			482	0.015	7¼	130	6	2"	"
7		11.93	2.46	9.47			320	0.025	8	86	6	2"	Fair. Cutting edges starting to wear
8		12.40	2.38	10.02			320	0.025	8	86	2	2"	
9		15.30	3.05	12.25			370	0.025	9¼	100	2	2"	
10		17.30	3.23	14.07			415	0.025	10⅜	112	2	2"	Corners Wearing
11		20.01	3.54	16.47			465	0.025	11⅝	125	2	2"	
12		25.70	3.68	22.02			482	0.025	12	130	1	1"	Drill burnt.

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Fig. 5. Report of Drill Test for Endurance

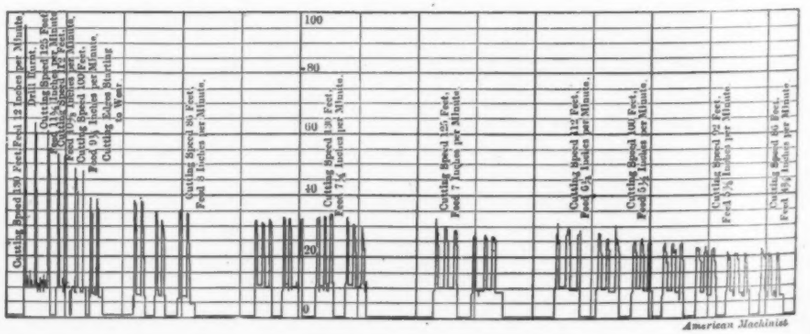
Cutting Speed 130 Feet. Feed 12 Inches per Minute. Drill Burnt.
Cutting Speed 125 Feet. Feed 11¼ Inches per Minute. Cutting Edges Starting to Wear.
Cutting Speed 100 Feet. Feed 10⅝ Inches per Minute.
Cutting Speed 100 Feet. Feed 9¼ Inches per Minute.
Cutting Speed 80 Feet. Feed 8 Inches per Minute. Cutting Edges Starting to Wear.
Cutting Speed 80 Feet. Feed 7 Inches per Minute.
Cutting Speed 120 Feet. Feed 7¼ Inches per Minute.
Cutting Speed 125 Feet. Feed 7 Inches per Minute.
Cutting Speed 115 Feet. Feed 6¼ Inches per Minute.
Cutting Speed 100 Feet. Feed 6¼ Inches per Minute.
Cutting Speed 72 Feet. Feed 5⅞ Inches per Minute.
Cutting Speed 80 Feet. Feed 5¾ Inches per Minute
100
80
60
40
20
0
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Fig. 6. Ammeter Diagram Corresponding with Report of Fig. 5

A noticeable feature during the breakdown test was that in every case with but two exceptions the twisted drills burned and the milled drills broke. This can be seen in Fig. 7, which shows the condition of some of the drills after the break-

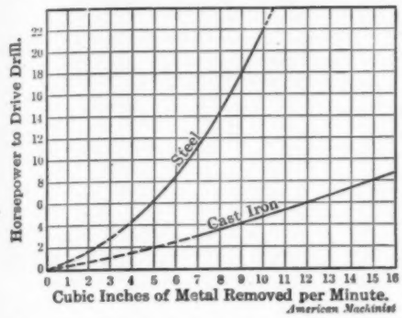


FIG. 10. RELATIONSHIP BETWEEN HORSEPOWER AND CUBIC INCHES OF METAL REMOVED PER MINUTE

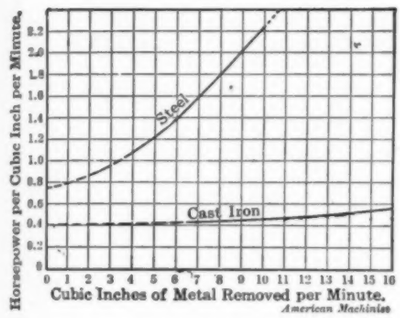
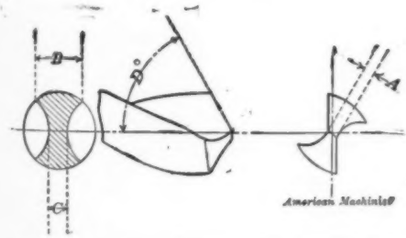


FIG. 11. RELATIONSHIP BETWEEN HORSEPOWER REQUIRED TO REMOVE ONE CUBIC INCH OF METAL PER MINUTE AND NUMBER OF CUBIC INCHES REMOVED



Drill.	Dimensions. A	B	C	D
A				59°
B				58°
C	0.132"		0.132"	59°
D				60°
E				58°
F				58°
G				60°
H				58°
I				58°
K				60°
M				58°
N				59°
O				60°
P				58°
Q				58°
S				58°
T				59°
U				62°
W				62°

FIG. 13. DIMENSIONS AND ANGLES OF DRILLS TESTED.

Drills taken off test when same required grinding.
Slight grinding will put drills in good condition.

ENDURANCE TEST.
MATERIAL DRILLED, CAST IRON.

Number of Holes Drilled.	Cutting Speed.	Feed per Revolution.	Feed per Minute.	Thickness of Material Drilled.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	W
8	92'	0.025	83"	3/4"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	25%
30	82'	0.045	133"	3/4"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	80%	93 1/3%	93 1/3%	73%	66 2/3%	66 2/3%	30%	6 2/3%	
47	100'	0.045	16 2/3"	3/4"	100%	100%	100%	66 2/3%	100%	43%	100%	100%	100%	100%	100%	50%										
	120'	0.045	20"	3/4"	100%	100%	66 2/3%	66 2/3%	66 2/3%		28 1/3%	28 1/3%	28 1/3%	28 1/3%												

ENDURANCE TEST.
MATERIAL DRILLED, OPEN-HEARTH.

Drills taken off test when cutting edges started to wear.

Number of Holes Drilled.	Cutting Speed.	Feed per Revolution.	Feed per Minute.	Thickness of Material Drilled.	CC.	TT.	NN	AA	HH	GG	DD	BB	II	FF	EE	QQ	RR	SS	OO	MM	JJ	WW	KK	UU	PP
6	86'	0.015	43"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	Drill Broke First Hole.
6	92'	0.015	51 1/2"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	100'	0.015	60"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	112'	0.015	68 3/4"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	125'	0.015	77"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	130'	0.015	80"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
9	86'	0.025	86"	2"	100%	100%	100%	66 2/3%	66 2/3%	33 1/3%	100%	100%	100%	100%	100%	66 2/3%	66 2/3%	66 2/3%	100%	100%	100%	83%	66 2/3%	33 1/3%	
6																									

BREAK DOWN TEST.
MATERIAL DRILLED, OPEN HEARTH STEEL.

Same test as above and continued until drills broke or burnt.

Number of Holes Drilled.	Cutting Speed.	Feed per Revolution.	Feed per Minute.	Thickness of Material Drilled.	CC.	DD.	NN.	IL.	TT	RR	HH	AA	SS	GG	WW	BB	QQ	EE	FF	MM	JJ	OO	KK	UU	PP
6	86'	0.015	43"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	92'	0.015	51 1/2"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	100'	0.015	60"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	112'	0.015	68 3/4"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	125'	0.015	77"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
6	130'	0.015	80"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
9	86'	0.025	86"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
8	100'	0.025	100"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	55%	33 1/3%	33 1/3%	
24	112'	0.025	112"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
24	125'	0.025	125"	2"	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
1	130'	0.025	12"	1"	50%							50%	25%	8 1/3%				50%							

FIG. 8. SUMMARY SHEET OF DRILL TEST BASED ON ENDURANCE PERFORMANCE.

down test in steel, and tends to prove that milled drills cut freer, but are more fragile than flat-twisted drills, and that there is a tendency for flat-twisted drills to burn at the point, due to the bluntness of the cutting edge.

Summary Reports

The table, Fig. 8, is a summary of tests based on the endurance efficiency of the drills regardless of power consumed. If a drill stood up in each series of feeds and speeds selected, its efficiency was rated at 100 per cent., and as drills failed the efficiency was based on the number of holes drilled. The blank spaces denote that drills failed to complete previous test.

The table, Fig. 9, is a summary chart giving the power efficiency of the drills tested. The drill consuming the least power for each feed and speed was rated 100 per cent. efficient, and other drills were rated in proportion to horsepower consumed, regardless of the number of holes drilled. The horsepower given in this table is the average actual power consumed in drilling, and does not include the power required to drive the machine. Naturally, as the speed of the machine increased, the power to drive the machine is increased, and by referring to Fig. 5, tests Nos. 6 and 7, it is interesting to note that when high speed with small feed is used, the machine consumes more power and the drill less power, and when less speed and greater feed is used, the machine consumes less power and the drill more power, but in both cases the total power and results in work done are about the same.

It is evident that with a properly constructed machine it is better to run at high speed and small feed, thereby prolonging the life of the drill.

Fig. 10 shows the relationship between the horsepower required to drive drills and the cubic inches of metal removed per minute.

Fig. 11 shows the relationship between the horsepower required to remove one cubic inch of metal per minute and the number of cubic inches removed.

These curves represent the average horsepower required to drive all drills used in this test and do not include the power to drive the machine. The power required to remove 1 cubic inch of metal remains very nearly constant when drilling cast iron, regardless of the number of cubic inches removed per minute. On steel the power increases more rapidly as the amount of metal removed per minute is increased. See Fig. 11. This is probably due to less resistance in drilling cast iron, as the chips generally break up, while in steel more power is consumed in bending or curling the chips, but it is safe to assume that this difference will not be so great when drilling holes of greater depth, as the steel chip

HORSE POWER TEST.
Material Drilled, Cast Iron.

Cutting Speed.	Feed per Revolution.	Feed per Minute.		S	A	G	Q	T	L	N	B	J	F	H	R	K	O	I	U	M	D	C	E	P	W
92′	0.025″	8¼″	H.P.	2.79	2.59	3.10	2.96	2.87	3.09	2.89	3.20	3.39	3.60	3.19	3.12	3.11	3.00	3.01	3.31	2.94	3.58	3.40	3.45	3.54	5.75
			%	93%	100%	83%	87%	90%	84%	90%	81%	76%	72%	81%	83%	83%	86%	86%	78%	88%	72%	76%	75%	73%	45%
82½′	0.045″	13¾″	H.P.	5.04	5.39	5.53	5.19	5.53	5.85	5.67	5.56	6.25	6.62	6.11	6.23	6.51	6.91	6.56	6.63	7.63	6.64	7.82	8.95	8.47	
			%	100%	93%	91%	97%	91%	86%	89%	92%	81%	76%	82%	81%	77%	73%	74%	76%	63%	76%	64%	56%	59%	
100′	0.045″	16¾″	H.P.		7.31	7.18			6.56		7.07	6.88	7.14	7.22		7.19		8.88			9.22	9.77	9.92		
			%		90%	91%			100%		93%	95%	92%	91%		80%		74%			71%	67%	66%		
120′	0.045″	20″	H.P.		8.67	8.26						9.74	8.72	10.22				10.69			10.07	10.43	10.30		
			%		95%	100%						85%	95%	81%				77%			82%	79%	82%		
Average			H.P.	96%	944%	91%	92%	904%	90%	894%	89%	84%	84%	84%	82%	80%	794%	784%	77%	754%	75%	714%	70%	66%	45%

HORSE POWER TEST.
Material Drilled, Open-hearth Steel.

Cutting Speed.	Feed per Revolution.	Feed per Minute.		AA	GG	QQ	HH	NN	CC	TT	DD	BB	EE	SS	H	UU	FF	RR	KK	JJ	PP	WW	MM	GO	
86′	0.015″	4¾″	H.P.	3.37	3.76	3.01	3.93	3.79	4.44	4.14	4.27	3.53	4.17	4.60	4.87	3.94	4.74	5.45	5.47	4.25	4.81	5.65	5.16	5.29	
			%	89%	80%	100%	76%	79%	68%	73%	70%	85%	72%	65%	62%	76%	63%	55%	55%	66%	62%	53%	58%	57%	
92′	0.015″	5¼″	H.P.	4.05	3.95	3.79	4.07	4.65	5.00	4.66	5.25	4.29	4.47	4.95	5.11	4.63	5.28	6.41	5.63	5.41		6.32	7.01	6.40	
			%	93%	96%	100%	93%	81%	75%	81%	72%	88%	85%	76%	74%	82%	71%	59%	67%	70%		60%	54%	59%	
100′	0.015″	5¾″	H.P.	4.24	4.32	4.99	5.14	5.16	5.69	5.21	6.36	4.81	5.32	5.46	5.64	5.45	5.87	6.87	6.10	6.64		6.99	7.76	9.62	
			%	100%	98%	85%	82%	82%	75%	81%	67%	88%	79%	78%	75%	78%	72%	62%	69%	64%		61%	55%	44%	
112′	0.015″	6¾″	H.P.	4.88	4.90	5.35	5.34	5.96	6.31	5.73	7.01	5.86	6.15	6.37	6.52	6.94		8.01	6.50	7.97		7.99	8.92	11.19	
			%	100%	99½%	91%	91%	82%	77%	85%	70%	83%	79%	76%	75%	55%		61%	75%	61%		61%	46%	43%	
125′	0.015″	7″	H.P.	5.35	5.97	6.03	6.30	6.59	7.08	6.65	8.08	7.53	6.35	7.72	8.85			9.18	9.05			9.23	9.43	13.98	
			%	100%	90%	89%	85%	81%	75%	80%	66%	71%	84%	69%	90%			58%	58%			58%	56%	37%	
130′	0.015″	7¾″	H.P.	6.76	6.68	6.96	6.91	7.29	8.83	7.67	9.16	6.36	7.54	8.00	8.61			9.22				10.77	11.08		
			%	99%	100%	96%	97%	92%	76%	87%	73%	80%	84%	83%	77%			72%				62%	60%		
86′	0.025″	8″	H.P.	9.10	8.75		9.00	9.27	9.70	9.80	9.07	11.61		9.69	12.38			11.70				14.54			
			%	96%	100%		97%	94%	90%	89%	96%	75%		90%	71%			75%				60%			
100′	0.025″	9¼″	H.P.	13.53	13.10		14.63	12.43	13.25	15.05	12.60			14.60	13.66			13.83				19.72			
			%	92%	95%		85%	100%	94%	82%	99%			85%	91%			90%				63%			
112′	0.025″	10¾″	H.P.					13.73	14.07	17.00	12.75				14.77			15.07							
			%					93%	91%	75%	100%				86%			85%							
125′	0.025″	11¾″	H.P.					18.79	16.67		15.28				16.97										
			%					81%	92%		100%				90%										
Average			H.P.	96%	95%	93½%	88%	86½%	81¾%	81%	81%	81%	80½%	77%	76%	73%	70%	68½%	65%	64½%	62%	60%	55%	48%	

FIG. 9. SUMMARY SHEET OF DRILL TEST GIVING POWER EFFICIENCY.

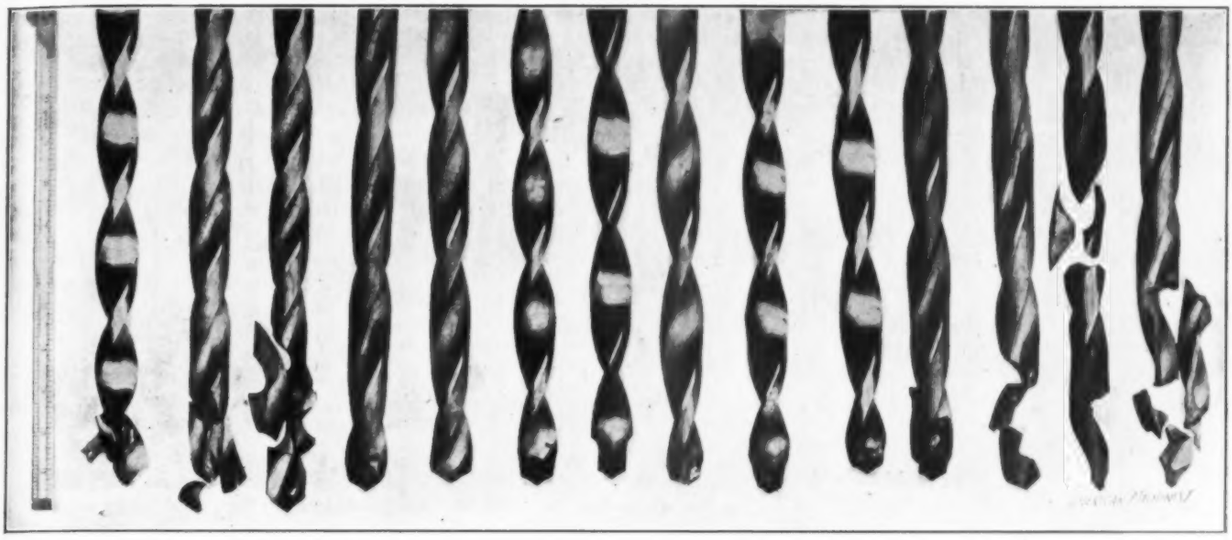


FIG. 7. SOME OF THE DRILLS AFTER THE BREAKDOWN TESTS IN STEEL

follows the flute of the drill, while cast-iron chips have a jamming action.

TUNGSTEN CONTENT OF THE DRILLS

It was determined by a chemical analysis of the steel from which the drills in this test were made, that the tungsten varies from 10.31 to 19.98, but by referring to the endurance test, Fig. 8, and comparing it with the analysis, Fig. 12, it will be noted that the efficiency of the drills is not proportional to the amount of tungsten used. It was apparent in some cases that the design and temper of the drills greatly affected their efficiency; for example, in the break-down test milled drill marked *T T*, though very low in tungsten, did considerable more work than milled drill *E E*, which is very high in tungsten. But drill marked *I I*, also high in tungsten, but of the forged-flute design, compares favorably with *T T*, which is low in tungsten, showing that the design of the drill must be taken into consideration as well as the amount of tungsten used.

The table, Fig. 13, gives the cutting angles of the different drills. The angles given are the original angles ground by the manufacturers, and drills were used just as received throughout the test; *A* is the width at the point of the drill, and *B* and *C* are dimensions on the body.

Fig. 14 shows a few specimen drill chips.

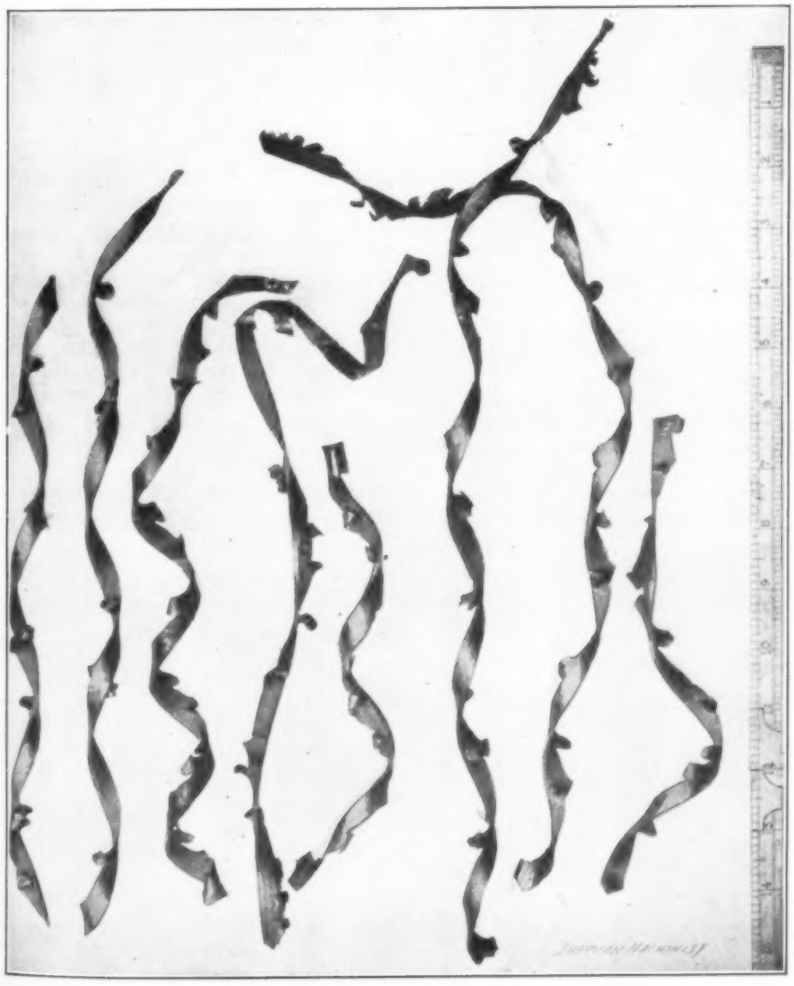


FIG. 14. SPECIMEN DRILL CHIPS

Some Troubles of the Drilling Machine Maker

BY JOHN R. GODFREY

The spring of metal is always with us and while we realize it in a vague sort of way when we can use it to our advantage, we seem to forget it in most other cases.

Perhaps the drilling machine or "driller" makers are up against this as hard as anyone, and some of them do not seem to appreciate all that it means.

A very light machine may show up splendidly with a test indicator so far as the spindle being square with the table goes, but the minute it begins to do work it is a different story. The pressure of the drill on the work tends to force the top of the column back and to throw the spindle out of square with the table. The larger the drill or the more pressure there is put on the drill point the more

this spring will be and the more trouble comes from holes not being drilled square with the table even after it tests O. K. with the drill idle.

Radials are even more susceptible to spring than the regular uprights owing to the overhanging arm. They are subject to both the spring of the arm and of the column. Some machines have been built with the columns tipped backward so that the weight of the arm brought it square. Others have tried tipping the column forward a trifle so that the pressure of the drill on the work would make the drill spindle square with the table. But it's a hard proposition any way you look at it.

When the drill starts to work it takes up all the slack of all the joints and also springs the column and the arm whatever they will give. When the drill point breaks through the hole, all the pressure is relieved, the drill is forced through the little remaining metal and away goes the drill point.

Symbol.	Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Tungsten.	Chromium.
A	0.48	0.20	0.014	0.010	0.40	15.86	3.46
B	0.41	trace	0.017	trace	0.57	17.29	3.24
C	0.41	trace	0.012	0.015	0.50	17.84	3.12
D	0.25	0.19	0.014	trace	0.50	16.18	3.05
E	0.38	0.05	0.010	0.012	0.28	19.98	4.95
F	0.43	0.32	0.012	0.018	0.27	15.80	2.28
G	0.49	0.19	0.018	0.012	0.28	19.45	2.89
H	0.44	0.14	0.016	trace	0.32	15.54	3.14
I	0.24	trace	0.023	0.012	0.27	19.43	4.07
J	0.48	0.14	0.017	0.037	0.21	13.88	2.96
K	0.46	trace	0.010	0.025	0.50	14.98	2.65
L	0.32	trace	0.018	0.045	0.35	18.00	3.05
M	0.45	0.09	0.015	0.017	0.55	17.80	2.89
N	0.54	trace	0.014	0.015	0.28	19.43	3.10
O	0.44	0.09	0.015	0.012	0.52	17.76	2.90
P	0.57	0.48	0.017	0.020	0.60	13.50	4.08
Q	0.43	0.19	0.018	0.038	0.28	19.51	3.00
R	0.49	0.10	0.019	0.015	0.48	18.79	4.70
S	0.55	trace	0.012	0.017	0.48	18.95	3.01
T	0.41	0.19	0.011	0.037	0.34	10.31	3.20
U	0.45	0.09	0.015	0.017	0.55	17.84	2.88
W	0.49	0.09	0.010	0.032	0.24	18.39	2.35

FIGURE 12. CHEMICAL ANALYSIS OF DRILLS TESTED.

Drilling Too Many Sizes of Holes

There is another point in the drilling question which is a very serious one for makers of all kinds of drilling machinery, and that is the great variation in the sizes of the holes to be drilled. While it may be necessary to provide for using large sizes of drills, we are altogether too much inclined to connect large drilling machines and large holes as necessarily going together. There is, however, no logical connection between a long arm on a radial, or a large capacity on a upright, and the size of hole to be drilled. The nature of the work often requires a long arm to reach the desired point where only a ¼-inch hole is wanted.

Whenever I see a heavy radial drill, with a 5- or 6-foot arm, with the drilling head very large and heavy, on account of the numerous gears necessary, I recall an instance of a little test made by a friend of mine who is in charge of a large shop doing quite heavy work.

He had in the neighborhood of 30 radial drills of about 6-foot swing, all of them of the old belt-driven type, which looked rather antiquated, as compared with some of the newer machines. He is always on the lookout for improvements and began looking into the merits of the new heavy-geared machine for this purpose. There was no question as to his machines being old, and he had very vivid recollections of occasional trouble with belts when large holes were being drilled, so that he began to consider the advisability of buying new machinery for his drilling department.

But before doing this he instructed the foreman of this department to keep a record of every hole drilled during a given week, in order to determine how powerful a machine would be needed.

Imagine his surprise to find that, although his work was considerably larger than found in the majority of shops, the average diameter of holes drilled on all his machines for an entire week was only ¾ of an inch.

This showed him very plainly that he did not require any more powerful machine for the great majority of his work, and that it was better to have a little trouble occasionally on a large hole than to wear out heavy-geared machinery in attempting to run a small drill at a speed which was even approximately efficient. By taking a little better care of the belting on these machines, he has practically eliminated all belt trouble, he secures an efficient drilling speed for the great majority of his work, and it is the most quiet drilling department that I know of.

This simply strengthens my own observation as to the average sizes of holes drilled in the majority of shops. In building machinery of ordinary sizes, the average diameter of drill is probably between ½ and ⅝ of an inch. And I do not know of anything which attracts my attention more quickly, or which proclaims its inefficiency more loudly, than to see a heavy-geared machine endeavoring to run a ¼-inch drill at somewhere near its proper cutting speed. It is not only in evidence by sight, but by sounds that are not easily forgotten.

Pattern and Core Box for Piston

By John A. Gledhill

Automobile pistons are made as thin as possible as the drawing shows. Note specially the side marked *F* 3/32 inch thick, Fig. 3.

The core box must be correct, or the thickness will vary. The core box illustrated was made in three pieces so as to draw off the core with the least rap-

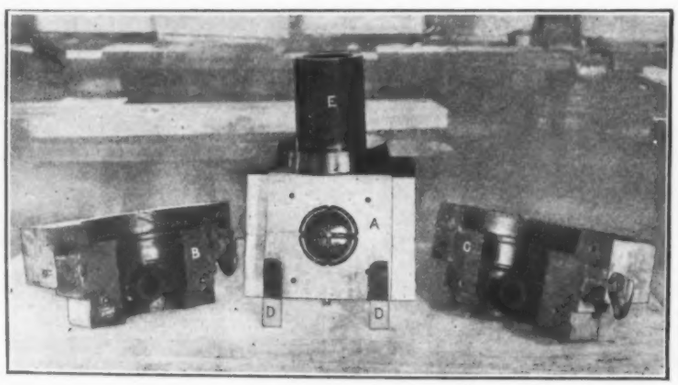


Fig. 1

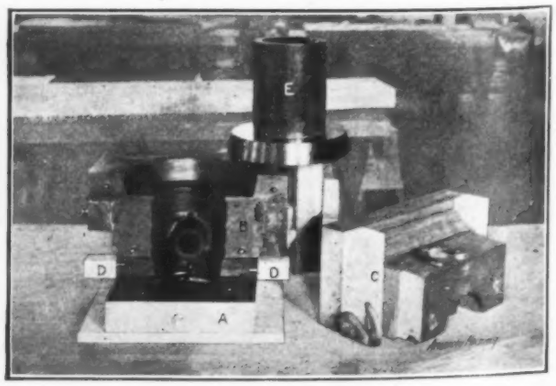


Fig. 2

Two Views of an Interesting Piston Core Box

ping. *A* is the bottom and *B C* the sides, which are located by dowel pins on *A*. Pieces *A*, *B* and *C* are held together by the hooks shown when the core is being made.

Pieces *D D* are loose ribs drawn from the core separately so that *B* and *C* can be drawn off the core. Dowels are used so that the loose ribs *D D* will always be located correctly in the core box.

As no sharp corners on the core coming in contact with metal were permitted, the core box was parted so as to have fillets in all corners. This is a very important feature which should be insisted upon by designers.

It is good practice to have the core box made as illustrated as it keeps its

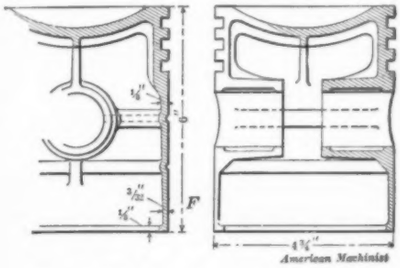


FIG. 3. DETAILS OF THE CORE BOX

shape and is not rapped to pieces. This particular pattern is in daily use and no difficulty is experienced.

The pattern is rather simple, *E* being the pattern and the flange below it the core print.

It is my experience that more bad castings are made in the foundry on fine core and thin castings, through sharp corners being allowed where fillets should be than from any other cause. The corners are too often left sharp to cheapen the pattern work.

Sawing Needle Plates for Knitting Machines

BY E. A. DIXIE

The Lamb Knitting Machine Company, Chicopee Falls, Mass., makes a variety of flat and circular knitting machines for the production of various fabrics ranging from the lightest underwear to heavy goods half an inch thick.

In knitting machinery, broadly speaking, but two varieties of needles are used, the spring needle, which is used in the manufacture of very light goods, and the latch needle, which is used for a wide range of work from very light to very heavy. The latter needle is used in all the machines built by the Lamb Knitting Machine Company.

The needles slide in slots in flat plates in the machines for flat goods and in slots in cylinders or cones in machines for producing cylindrical work, such as seamless stockings. The spacing of the slots in the plates must be very accurate and the width of each slot must be the same as every other slot.

Fig. 1 at *A* shows a machine-steel plate milled ready to saw the slots and *B* shows the finished plate. The slots run as fine as 16 and as coarse as 2½ per inch.

Fig. 2 shows two gangs of saws on their arbors at the grinder. That shown at *C* is for slotting the plates for machines on which sweaters are made and the saws are spaced 2½ per inch. The saws themselves are a little over three inches in diameter 6 gage. The washers are 2½ inches in diameter and the same gage as the saws. The gang of saws at *D* is for fine work with 12 slots to the inch. These saws are the same diameter, but are 36 gage in thickness. Each mandrel holds 8 inches of saws.

The saws are sharpened as shown by grinding the tops of the teeth, the finger *E* locating each row of teeth.

Fig. 3 shows the plates *F* mounted in a special sawing machine built by the Garvin Machine Company, New York. The plates range in length from 8 to 30 inches. They are set in the machine two at a time and as they are 4¼ inches wide the traverse of the table and work is a little over 8½ inches. In all cases the gang of cutters is 8 inches in length and when long plates are to be cut the shift is by hand using the hand wheel and screw *H*.

The total depth of cut in all cases is ¼ inch. The saws run about 48 turns per minute, lard oil being used as a

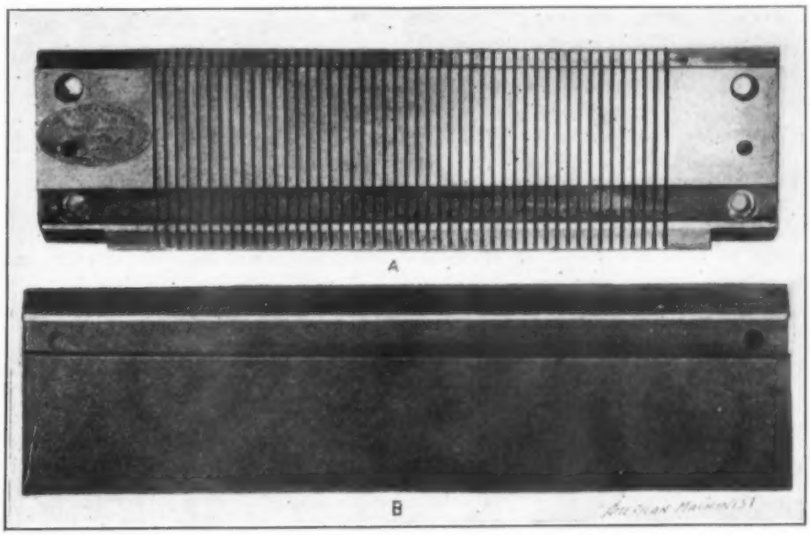


FIG. 1. KNITTING-MACHINE PLATES

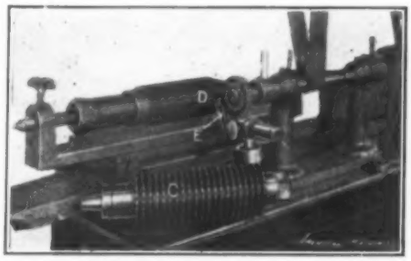


FIG. 2. SHARPENING THE SAWS

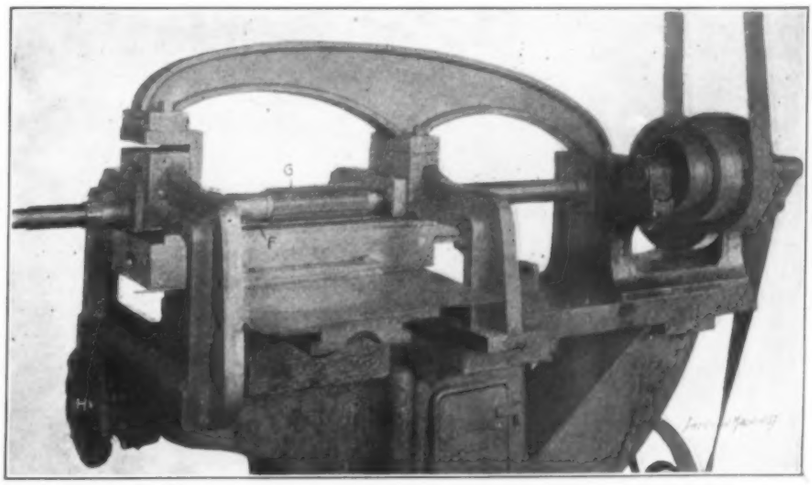


FIG. 3. SAWING KNITTING-MACHINE PLATES

lubricant. For the finer slots, 30 or 36 gage, the ¼-inch depth of cut is taken in from 9 to 10 cuts. The six-gage saws on slots 2½ per inch take the ¼-inch depth of cut in four cuts. On the coarser slots the automatic feed is about one inch in four minutes. Cutting two 30 plates with slots 12 per inch takes about three days, making three shifts of the 8-inch gang of cutters.

Blackboards for Tracing and Routing

By H. M. Wood*

The Lodge & Shipley Machine Tool Company has recently assigned a letter to each separate department in its plant, so that the departments can be referred to by letters only. Some of these department letters are shown in Fig. 1 attached to the columns at either side of the center bay. By being able to thus refer to each deparment by letter, the work of keeping records of the progress of the different parts through the shop from one department to another is greatly facilitated.

In the superintendent's office are several large blackboards on which are permanently painted the piece numbers of all parts entering into the construction of a lathe; opposite each piece number is a series of letters showing the different departments through which that piece must pass. A section of one of these blackboards is shown in Fig. 2. Across the top of the board is written in chalk 50 - 18" Lathes - Lot No. 2015. This heading is changed with each succeeding lot. There are four of these blackboards because four lots are simultaneously in the shop.

The piece numbers and department letters are painted on the board permanently, because whether the lot of lathes under construction is 18-inch size or 30-inch, the machines themselves will contain similar parts designated by the same numbers, and corresponding parts on all sizes of lathes will pass through the same departments of the shop.

To enable one who may not be familiar with the piece numbers to identify the different parts, there is a printed card above the board giving a complete parts list. Fig. 3 shows a portion of this card.

Special trace clerks keep after the work while it is in the shop to see that it is moved promptly from one department to another. They record on the blackboard the information as to the progress of the different parts through the shop, by drawing a chalk mark through each department letter as the lot of pieces successively leave the different departments. For example, by referring to the blackboard, if we notice that opposite to piece No. 785 letters *C* and *G* have been chalked off we know that the lot of first pinions and stems for these 18-inch lathes has already passed through the machine operations performed in departments *C* and *G* and is at present in department *K*. Thus the progress of the work on every part of all lathes under construction in the shop can be seen at a glance. If certain parts should be behind time, indicating that unless they receive special attention they may delay the completion of the entire lot, the superintendent notices the fact at once and is able to give the matter special attention.

In working out the system, it was found that there were not enough letters in the alphabet to cover all of the departments in the plant. To get around this difficulty, each department in shop number one is designated by a single letter; in shop number two the departments are designated AA, BB, etc. Then on the blackboard, to prevent confusion which would be occasioned by duplicating letters, yellow paint is used for letters designating shop number one and white paint for letters corresponding to departments in shop number two.

50—18" Lathes, Lot No. 2015.

Piece No.		Picee No.		Piece No.		Piece No.	
0510	S B D C G R Q	681	S F I B C A G F G S Q N I C I	785	C G K A C R	900	S B D C B I C I G N I Q
0511	S B D C G R G	682	F G	787	E D E C G D N I R	901	E B D E I

FIG. 2. PORTION OF BLACKBOARD.

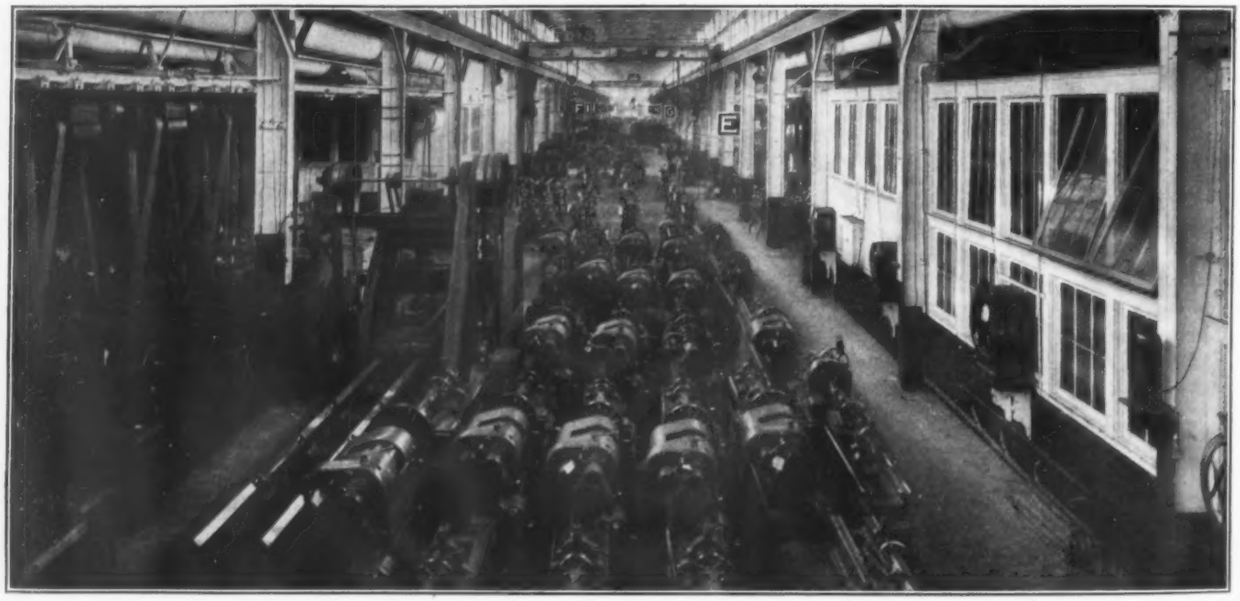


FIG. 1. SHOP NO. 1 SHOWING DEPARTMENT NUMBERS

785—First pinion and stem.
787—First pinion and bush.
790—Follow rest back jaw.
791—Follow rest body.
792—Follow rest upper jaw.

FIG. 3. PORTION OF PARTS LIST.

There is no standard mixture for phosphor-bronze, and legally any bronze which contains phosphorus, however small, can be called by this name.—*Brass World.*

*With Lodge & Shipley Machine Tool Company.

Broaching Parts of Lifting Jacks

By F. A. Stanley*

How round, hexagonal and square holes are finished in gear blanks, jack bases, rockers and other parts, by broaching under a hydraulic press. Cylindrical hole 2⅝ inches in diameter in a cast steel gear hub opened out to hexagon form by a single pass of a broach.

Method of finishing a hole and leaving a solid key in the neck of a jack base for the reception of the ram, by forcing through a pair of broaches, which form the key at the same time as the cylindrical bearing surface.

Details of tools, holding fixtures and general proportions of the work itself.

*Western editor.

The Joyce-Cridland Company, of Dayton, Ohio, machine a number of the parts used in their lifting jacks by means of broaching operations performed in an 80-ton hydraulic press of their own manufacture.

Character of the Work

Some of the jack parts handled in this manner are illustrated in Fig. 1, which is a group representing several sizes and forms of broaches, a number of gear wheels for automatic geared-lever jacks; a screw-journal jack frame, and several parts for jacks of other types.

The hexagonal holes in the gears are broached before the teeth are cut, as indicated by the engraving, which shows a blank with the hole chucked through the hub, and a pair of such gears with broached bores, one before cutting the teeth, the other after. These gears are steel castings and they are made in various sizes for the different jacks. The ones illustrated are 12 inches diameter, as shown by the sketch, Fig. 2, which is a sectional view and plan with the general dimensions given.

Broaching the Hexagonal Hole

As will be seen from the sketch, the hexagonal hole in the gear hub is 2⅝ across flats, and the distance through the hub is 3 inches. The work is performed in the hydraulic press shown in Fig. 3, with the gear blank placed in a fixture, through which the broach can pass, on its way down through the work. The broach is represented in detail in the drawing, Fig. 4, and from this layout it will be seen that the total length of the tool is 21½ inches, with a cutting length of 17 inches, divided into 14 cutting edges so proportioned in regard to diameter across corners as to divide the work properly from one end of the broach to the other in opening out the bore from the cylindrical form to the hexagon.

The operation is completed with one broach, leaving an accurate, smooth hole which in the assembling of the jack, receives the six-sided hub of the pinion that operates the jack bar or ram.

Forming a Solid Key in a Broached Hole

In the foreground of Fig. 3 there are a number of bases or frames for screw-operated journal jacks, and one of these bases will be noticed to the right of the group of work and tools in Fig. 1. A cylindrical ram is used in this jack, the operating screw passing up inside the lower end of the ram, and the latter having a keyway fitting a solid key in the neck of the base that prevents the ram from rotating with the motion of the screw. This key is plainly visible in the cylindrical opening at the top of the

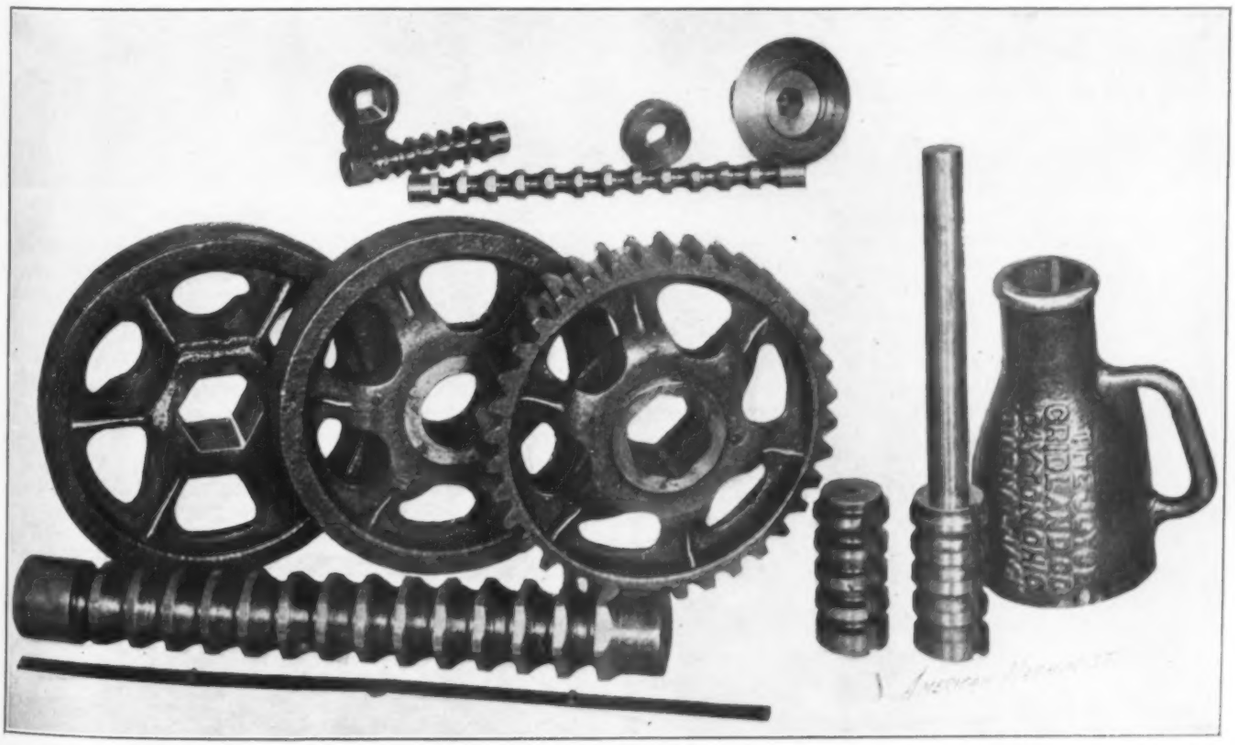


Fig. 1. Some Lifting-Jack Parts with Bores Finished by Broaching

jack base in Fig. 1. It is about ⅜ inch wide in the size of jack illustrated, and is formed at the same time as the hole itself is finished.

Two broaches are used for this operation, both of which are shown at the side of the jack base in Fig. 1. The one at the left, that is, the solid broach, performs the roughing of the bearing, while the other, which is bored out to receive a guide arbor, is used for finishing.

Order of Operations

The broaching is accomplished under the same press as illustrated in Fig. 3. The first, or roughing broach is pushed through the cored hole, leaving a few thousandths inch of metal all the way round the hole and key for finishing. The jack base then goes to the drill press,

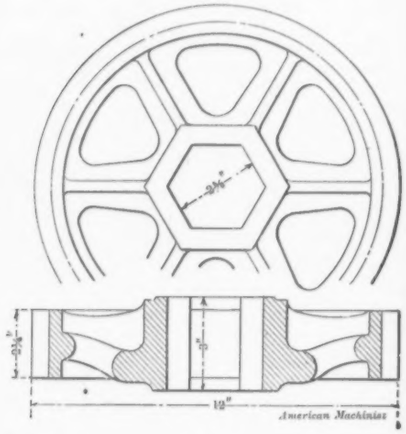


Fig. 2. Gear with Broached Hexagonal Hole

where, with the equipment in Fig. 5, a hole is put through the bottom for the lower end of the jack screw and a concave seat machined for the reception of the lower bearing plate of a roller bearing which takes the load on the screw.

For the drill-press operations a bushing is placed in the bearing opening broached in the top of the jack base, and with this as a guide for the tools, the operations at the bottom of the cast-steel shell are performed. The machining of the seat for the roller bearing is accomplished with a cutter head attached as shown, to a bar guided at the upper end in the bushing and piloted at the bottom. This cutter head is made in such form as to be readily attached to and removed from the bar, and the depth of the seat is gaged by the device shown at the front of the work.

The gage referred to consists of a plate corresponding to the cover plate of the jack, and having a stud projecting from the inner face, through which passes the stem of a micrometer.

The Finish-broaching Process

After the work in the drill press is completed, the jack bases are taken back to the hydraulic press where, with the second broach, the bearing surface for the ram and the controlling key are finished.

In this operation, which is illustrated in Fig. 6, the broach is guided on a spindle or arbor that passes down through the hole at the bottom of the jack base and assures the broach taking a true course down through the neck of the casting, leaving a smooth cylindrical guide for the ram, and a straight, correctly sized key for the splined guide in the side of the ram.

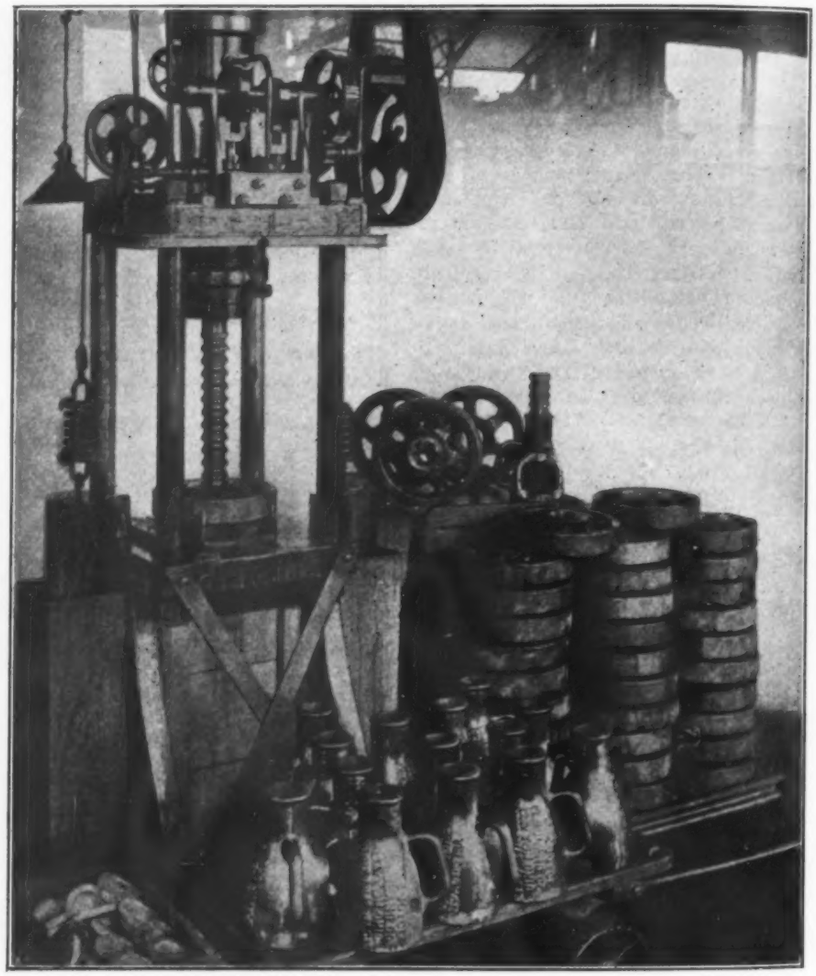


Fig. 3 Broaching Hexagon Hole through Gear-blank Hubs

Broaching Out a Bevel-gear Hub

A bevel gear is shown in the background of Fig. 1, with a long broach in front with which a hexagonal hole is formed in the gear hub. This gear is used on the hexagonal shank of the ele-

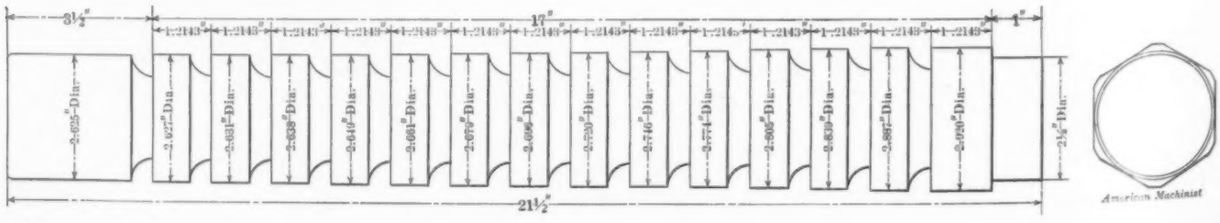


Fig. 4. A Long Hexagonal Broach

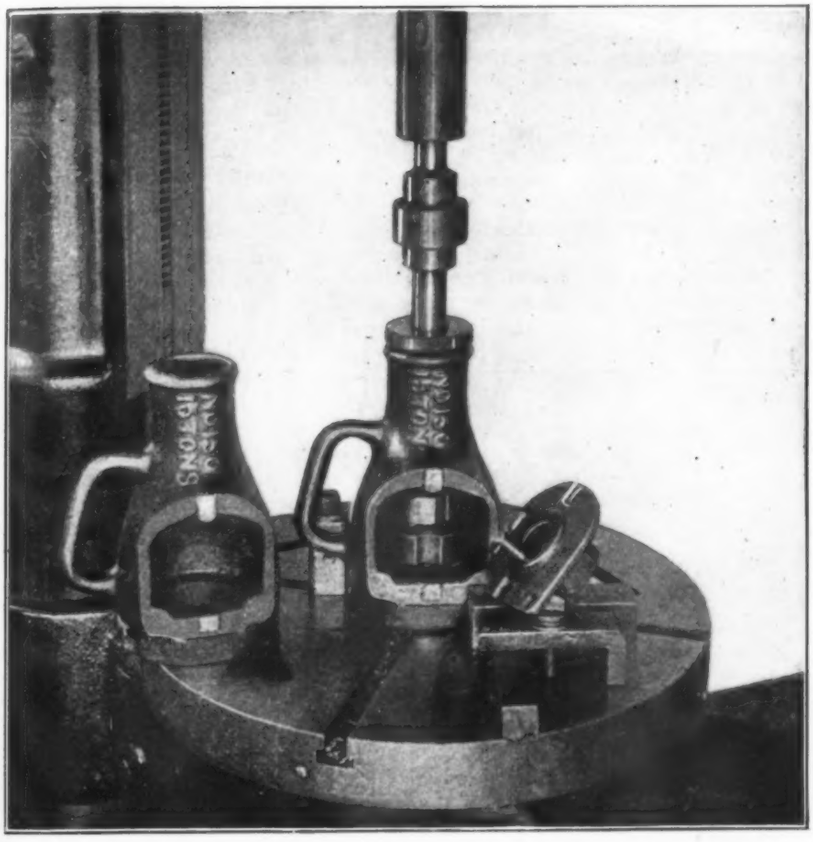


FIG. 5. FACING A CONCAVE SEAT IN THE BASE OF A JACK

vating screw of the jack. Fig. 7 illustrates the work and broach more clearly and also shows the fixture in which the gear is held during the operation under the hydraulic press. The approximate dimensions of the gear are given on the sketch, Fig. 8.

As noted on the sketch, the hexagonal hole is 1 inch across flats, and is about 1⅛ inches deep. The material is a tough grade of steel. The gear blank is slipped into the fixture, Fig. 7, and the broach is guided by the bore of the gear and the bushing secured in the top of the fixture. The cut is divided over 12 cutting edges and one broach does the work.

OTHER APPLICATIONS

Alongside of the bevel-gear blank in Fig. 1, there is a collar-shaped piece of steel in which a hexagonal hole is broached in the same way as in the bevel gear. This collar is really a blank for the ratchet which operates the jack screw, and is fitted upon the hexagon shank of a pinion that engages with the bevel gear, Figs. 7 and 8. After the broaching operation has been accomplished in a fixture like that in Fig. 7, the periphery is provided with a series of square teeth of slighting undercut section, by gashing with a narrow milling cutter. These teeth are adapted to be engaged by the ratchet pawl or dog, which works back and forth with the lever to actuate the jack screw.

Still another interesting application of the broaching process is represented by the production of the square hole through the steel piece shown to the left in the background of Fig. 1. The piece of work is a rocker arm for actuating the pump plunger of a hydraulic jack. The square hole is finished in one operation with the short broach shown immediately in front of the work.

System for Filing Tracings

BY LLOYD H. CARTER

Filing of drawings is a problem for which there probably is no one solution. Each line of manufacture has its peculiarity lending itself more freely to one system than to another, but no doubt some systems will cover a variety of allied lines.

Some years ago I left a large company where my work had been connected with very extensive plant improvements and the system of filing drawings had involved a card index with major-, minor- and sub-divisions, together with rather elaborate cross indexing. Such a system

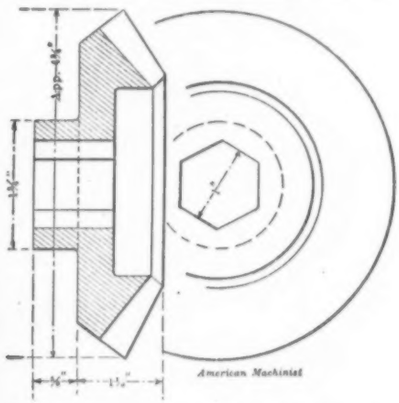


FIG. 8. BEVEL GEAR WITH HEXAGONAL BROACHED HOLE IN HUB

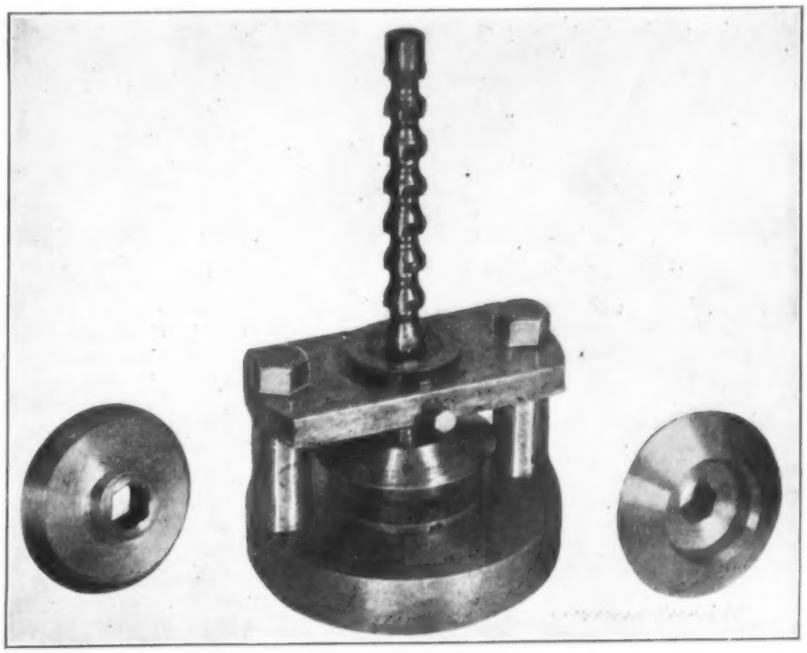


FIG. 7. BROACHING TOOLS FOR BEVEL-GEAR BLANKS

required a clerk whose only duties were to attend to this index, file and find tracings for a force of about 40 draftsmen.

My next position was in the drawing offices of a firm manufacturing power-driven pressure pumps on an extended scale, and the simple filing system which there was used seemed positively crude to me. Further acquaintance, however, showed me its wonderful effectiveness and, because it required practically no clerical work at all, its great economy. This system is somewhat limited in its usefulness and may not be new where it is most applicable, but a description will be of interest, no doubt.

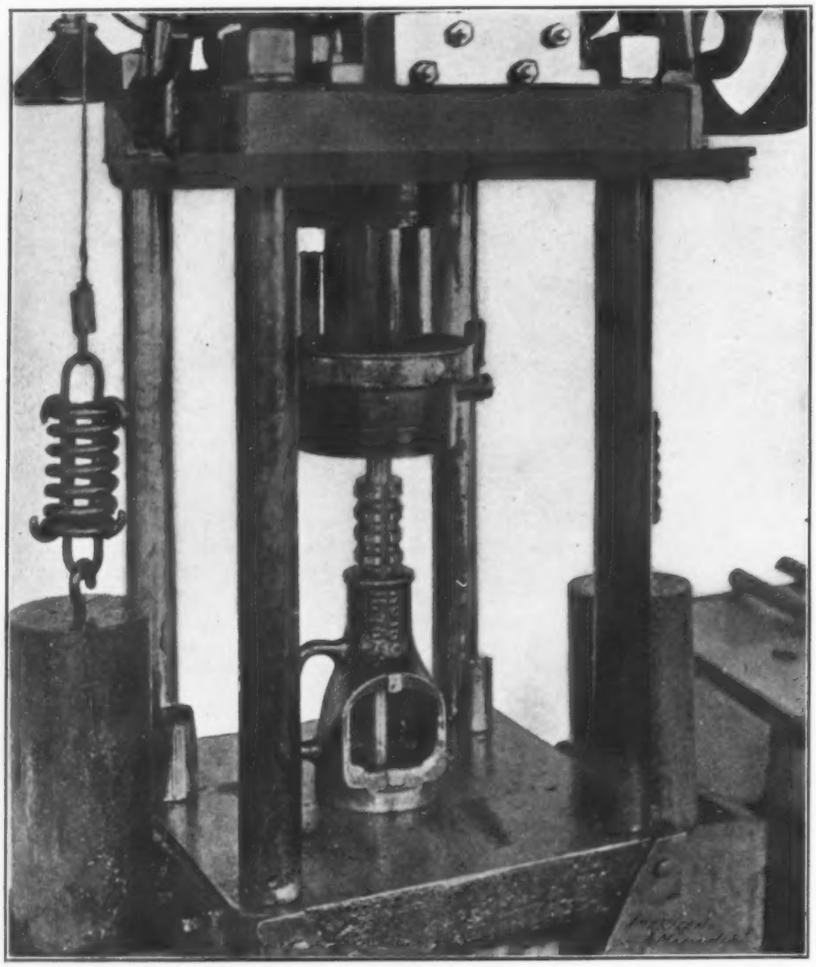


FIG. 6. BROACHING A GUIDE BEARING AND SOLID KEY IN JACK BASE FOR THE RAM

CHARACTERISTICS OF THE PRODUCT

In the first place, consider the nature of the product. As said, this was an extensive line of power-driven pressure pumps, made in standard sizes in several classes; the latter divisions referring very largely to the method of drive, and the shape of the frames and bed as best suited to different purposes.

In such machines the essential characteristics are, of course, the water capacity and head or pressure against which they are intended to operate. To secure best economy of both material and power, these pumps were made and sold as near as possible to the requirements of the customer; that is, if a given pump were good for 200 feet head and 1000 gallons, it was not sold for 100 feet head. In such a case a smaller, lighter-built pump, but having the same plunger displacement. was offered at a cheaper price.

This brings us to the true, essential base; the product of capacity by pressure determines horsepower, and the frames, bearings, cranks, pins, rods, shafts and gears were built to withstand certain stresses which, at the rated and economical speed, determined the "horsepower of the frames." Then, when a customer desired a pump for a certain capacity against a certain head, the horsepower required was figured and plungers and barrels of the correct displacement were fitted to the frames coming nearest to the required horsepower.

Power required for these pumps ranged from small ones to be driven by a 15-horsepower motor, up to several hundred horsepower, and as the powers increased, not only were the parts made heavier, but the plunger strokes were made longer. Thus the sizes ranged by *length of stroke* (not diameters) and each stroke had its own rated horsepower which it was fully able to handle.

ARRANGEMENT OF VAULT

This natural division by length of stroke gave the basis for the filing of the tracings. First, groups of drawers in the vault were assigned to the various pump classes and these again were arranged one drawer to a stroke length of each particular class. Into each proper drawer then were put all of the drawings for the frames, shafts, cranks, connecting rods, gears and all such parts of which there was only one drawing for any one class and stroke length. Together with these also were put the drawings of all the barrels and plungers used with these parts of the corresponding stroke to give the different capacities to suit the various pumping heads or pressures.

When a draftsman finished a new drawing he put on the title, giving the class and stroke length. He then entered this title in a drawing-record book opposite the first number for which there was as yet no drawing made. This number then was put on the lower left- and upper right-hand corners of the drawing where it could be seen with ease, no matter which side up the drawing was laid in the filing drawer. This tracing was finally filed in the proper drawer, according to class and stroke, no attention being given to the actual number of the drawing.

Whenever a new class of pump was designed, a drawing list was made on tracing cloth, giving the number of each and every drawing required to complete that particular stroke of machine. There were, of course, several barrel and plunger drawings for each stroke, but in ordering to the shop, only that drawing showing the desired parts was mentioned.

It was the rule, as in most modern drawing rooms, to put as far as possible but one part on any one tracing. If it should happen that a drawing of a certain part was used for more than one class of stroke, its number would, of course, appear in as many drawing lists as necessary. Then, if there were any difficulty in locating such a drawing, not knowing precisely to which class or stroke the part might originally have belonged, a glance into the drawing-record book, in which the numbers were consecutively arranged, would show instantly where it should be filed and found. There seldom was trouble from this cause.

It would be hard, it seems to me, to imagine a better and more effective filing system for this particular class of work, and I believe there are other lines where it would apply equally well. Its almost complete lack of clerical attention required certainly is attractive.

French Automatic Turret Machine

By Carlos Lossow *

Mechanical details of a new machine, with cutting feeds and speeds recommended from French practice.

*Executive engineer of Bourel & Vieira, Paris, France.

The machine-building firm of Bourel & Vieira, Paris, France, has recently brought out a line of four automatic turret machines designated Nos. 1 to 4, inclusive. The sizes expressed in the diameter of the largest size of stock that can be machined, are 11, 16, 21 and 26 millimeters (0.44, 0.64, 0.84 and 1.04 inch). These machines, which I will describe, are constructed on new models, comprising a number of improvements, the principal ones of which are as follows:

1. All the levers controlling the various movements and all the parts requiring adjustment are placed at the sides and on the outside of the machine, which facilitates adjustment.

2. All the gears and ball bearings, both radial and thrust, are placed in housings forming oil reservoirs.

3. The number of different speeds of the cam shaft permits machining any piece whose dimensions are not greater than those for which the machine is intended.

4. The gear box controlling the feeds is so arranged that, even when working, it is possible to change from one feed to another by the simple movement of a draw rod.

5. The wirefeed is by a counterweight, the force of which is brought to act on a thrust block, which assures regularity in the lengths of the pieces of work.

6. The stock guard is easily changed and adjusted.

7. The spindle and all shafts turning at high speed are mounted on ball bearings.

8. All slides, as well as their guides, are of steel, hardened and carefully fitted.

9. All cams are traced on disks of a single size for each size of machine; they can be put in place quickly and without trials, because of the graduations in degrees on the cam plates.

Since the cams may be made of cast iron their price is low.

10. Toolholders, adjustable to all directions, allow the use of simple tools.

11. The arrangement of the cross-slide permits turning tapered work without a special appliance.

12. The pump piping is arranged to lubricate plentifully, and directly on the work. The oil is gathered by gutters in the bed of the machine, collected, filtered and stored in a reservoir in the frame. The pump gearing is placed below the bed, and is positively driven by gears and a universal joint.

Construction of the Machines

The frame or bed 1 (see the illustrations) is fixed on a pedestal 2, widened upward, basin-shape, and forming a reservoir for the oil required in lubrication of the work. At the base of the pedestal is a small geared pump 4, which receives the oil from the reservoir 2, and forces it to the tools by a pipe 6, Fig. 4. The pump is driven by a vertical universal-joint shaft 7, carrying the pinion 8, driven by the feed shaft.

The oil guards, 9 and 10, are hinged at 9a and 10a as shown.

On the frame is the headstock 11, the longitudinal slide 12, and the turret slide 13.

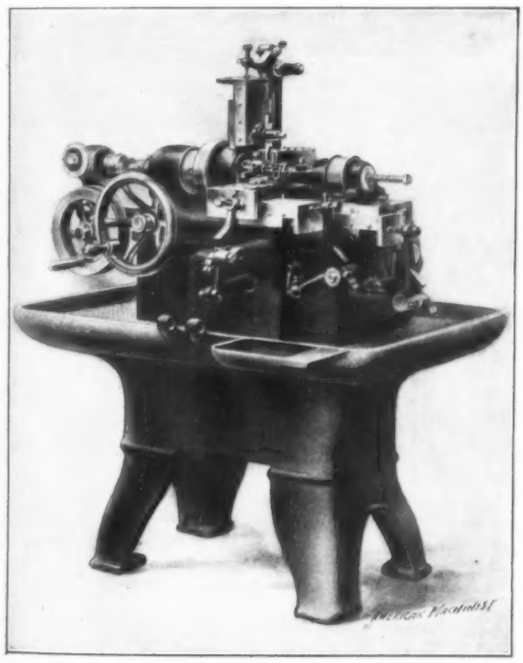


Fig. 1. French Automatic Turret Machine

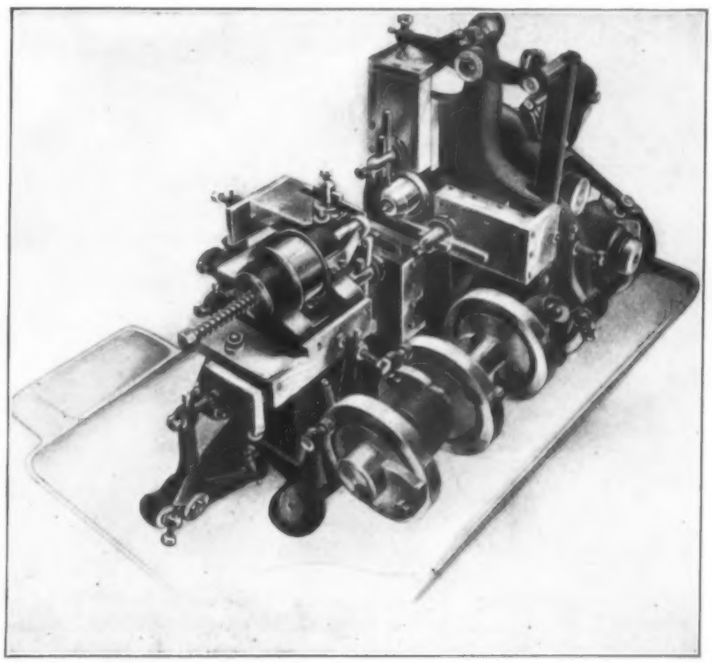


Fig. 2. Working Parts of French Automatic

The headstock carries a hollow spindle of hardened steel, 14. The main bearings of this spindle are ball bearings with several rows of balls, and the thrust and counterthrust bearings are likewise ball bearings. This allows very high speed without danger of heating. The thrust and radial ball bearings are designed to stand loads 20 times greater than the maximum which they are required to undergo during work. They are proof against dust and chips and turn in oil baths. The two-step cone pulley 17 is screwed on the shaft to allow adjustment of the pressure on the ball-thrust bearings.

The work is gripped by means of a

double-tapered chuck 18, which on one hand enters the closer on the end of the spindle and on the other hand takes the thrust of the conical tapered end of tube 19, surrounding the rod and sliding in the spindle. This tube is actuated by the jaws 20 and 20a, pivoted as shown and spread apart by a spool 23 which is connected with the lever 24 whose motion is produced by a cam 25, keyed on the cam shaft 26. The chuck has according to the size of the machine a length from 40 to 70 millimeters (1.6 to 2.8 inches).

The stock is guided in a guard 36, Fig. 6. The rod is automatically fed at each release of the chuck by a counter-weight 38, variable in load, which unwraps a cord 39, passing over suitable transmission pulleys, and it is connected with a thrust-block 40 on end of the stock.

The headstock carries three arms arranged 90 degrees apart, each of which has a tool slide, see Fig. 2. These three slides, like two others of which I shall speak later, are entirely of steel, hardened and ground and slide on guides also hardened and ground. The tool holders have micrometer adjustments in every direction.

One of the three slides, that is 41, may carry a stop, 43 may carry a forming tool, and 42 a cutting-off tool.

In front is fixed a guide 44 carrying a traverse slide 12, parallel to the axis of the machine.

This slide carries a tool carriage moving perpendicular to the axis of the machine. Slide 12 is used to turn work of any length. The position of the lever motion arrangement allows also of taper turning.

On the front of the turret is a tool holder 47, different from the others and serving especially for drilling, tapping, chambering and reaming, facing or other similar end work, and which in addition may be used for a back center, or rest.

The tool slide is so arranged as to take several tools (two for example, as indicated in the drawing) which, by a cross movement may be brought successively in front of the spindle. The movement along the axis of the lathe feeds the tools to the work. This device may be entirely removed to allow of introducing a bar of stock from the front of the machine if it is necessary.

The movement for drilling and tapping is made without interfering with any adjustment, by removing a key which serves to fasten it in place. One tool is always centered without the use of the cams by a small block and adjusting screw. Spindle 74 has a rotary movement, either in the same direction of the main spindle for tapping at reduced speed, or in the opposite direction for drilling small holes at high speed. This shaft is likewise mounted on ball bearings. For threading, the die or tap is mounted in the tap holder and the release at the end of the cut is accomplished by trip. A spring pawl, at the desired moment, holds the tap or die for withdrawing.

The Cam Shaft and Cams

All the slides are driven by a single cam shaft 26, which also carries the cam which controls the clamping and releasing of the stock.

Cams 51 drive the various movements of the slides and tool holders and are fixed to the cam plates 52, keyed on the cam shaft. The various movements are transmitted in a similar manner, starting from the cams, by levers 54, connecting rods, bell cranks 56 or oscillating levers 56a, one arm of which ends in a screw 57, for micrometer adjustment of the movement of the tools, acting on a boss 58. Each lever carries, moreover, near its pivot, a boss 59 against which rests a screw 60, for adjusting the travel of the slide.

The plates 52, which receive the cams, have on each side a circular slot of dovetail cross-section. The cams are cut to the proper profile in disks 51, which carry on one side a raised ring 51a, to engage in the corresponding slot 62 of the plate, which is to hold the cam. The cam is fixed on this plate by means of a bolt 63, the head of which is held in the slot 62, and the shank of which passes through a hole in the cam plate and disk.

According to circumstances, the cams

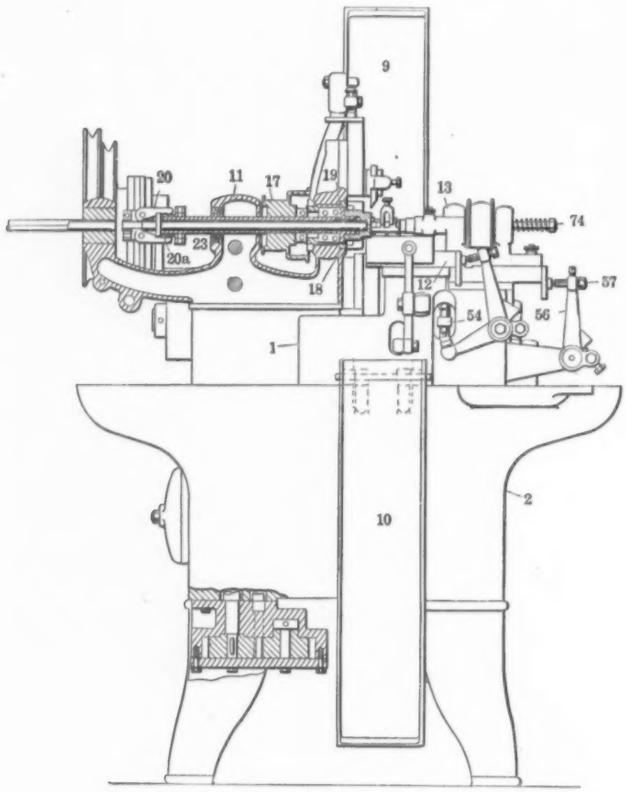


Fig. 3.

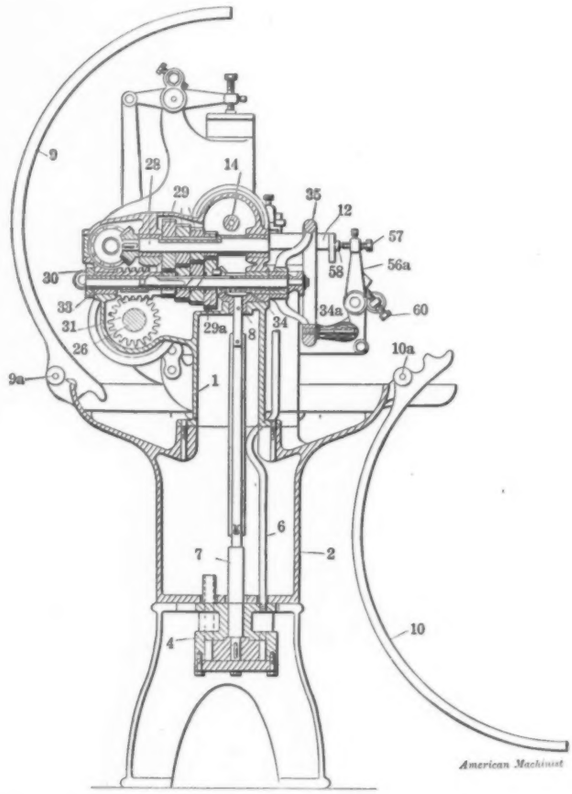


Fig. 4.

Elevations of French Automatics

act successively, or sometimes simultaneously when, for example, it is possible to begin a cut before the preceding cut is finished.

To facilitate the fastening of the cams on the cam plates, the latter are so graduated in degrees that it is easy to find the exact angular position of each. The movement of the various tools is then controlled by the hand wheel. In this manner, for each kind of work, there is a series of cams cut out according to the disk 51, and they are put in place on the plates 52, without trial, according

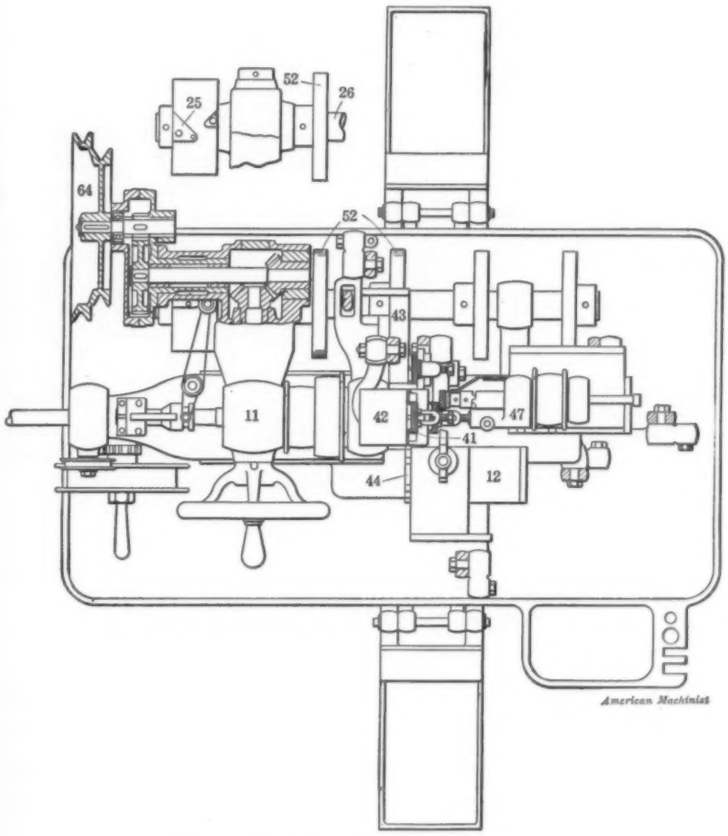


FIG. 5. PLAN OF FRENCH AUTOMATIC

to the scheme of mounting, which has been arranged for each piece of work.

Referring to the horizontal plan of the machines, the cams are arranged upon it as follows:

A, longitudinal movement of turret for drilling and tapping; *B*, cross movement of the turret for drilling and tapping; *C*, longitudinal motion of front slide; *D*, cross motion of front slide; *E*, motion of lower headstock slide; *F*, motion of horizontal headstock slide; *H*, motion of vertical headstock slide; *T*, drum carrying the permanent cams which control the chucking and unchucking of the work. The time taken for this operation is a constant, and for all sizes of the machine is 1/12 of a cam-shaft revolution. The total length of the chucking and unchucking cams is, therefore, 30 degrees on the circumference of the cam plates.

A round-belt pulley 64, driven by the countershaft, drives through two spur gears and two 45-degree bevel gears, to the shaft 28, on which are keyed the gears 29, which drive the gears 29a loose on the hollow shaft 33. The worm 30 drives the worm wheel 31, keyed on the cam shaft 26. The different speeds are obtained, changed or disconnected instantaneously by means of a movable key seated in the hollow shaft 33 by a draw rod 34, ending in a knob 34a. The movement is disconnected when the draw rod is at the end of its course in the two directions.

A handwheel 35, with crank, is used to work the cam shaft by hand, and thus to adjust the movement of the tools. It is easily removed or put back in place.

The countershaft has tight and loose driving pulleys, and it carries the round-belt cone driving the feed, the flat-belt cone driving the main spindle, and the pulley driving the tapping spindle.

In order to be able to determine the cams driving the feed movement of the tap, it goes without saying that there is need to know the actual speed of the tap and that of the spindle.

Let us call, for example, V_1 the fast, and V_2 the slow speed of the spindle, and V the speed given to the tapping spindle by the countershaft. The rotation of the two spindles being in the same direction, the two actual speeds of the tap will be the differences:

$$V_3 = V - V_2.$$
$$V_4 = V - V_1$$

SPEEDS AND FEEDS

The conditions under which different work may be done advantageously are so variable that it is almost impossible to lay down exact rules for the speed of the spindle and feed of the tools; and what I give here is only a suggestion.

I have endeavored, however, to give a general rule which will be of use in

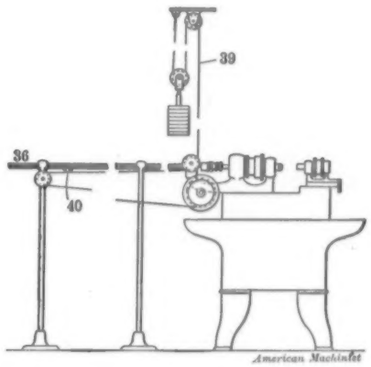


FIG. 6. DETAIL OF WIRE FEED FOR FRENCH AUTOMATIC

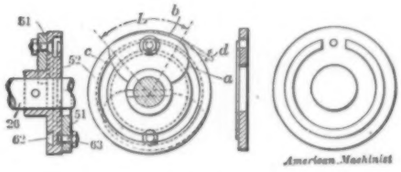


FIG. 7. DETAILS OF CAMS FOR FRENCH AUTOMATIC

setting up a machine and tracing the cams.

The speeds and feeds given can only be employed with an abundant lubrication of good American lard oil, or rapeseed oil, and having the tools well sharpened.

In Brass—Brass of ordinary quality may be turned at the highest speed. This may be given as 80 to 100 meters per minute (240 to 300 feet) cutting speed if high-speed steels are used as material for the tools.

Hollow mills may be fed at a speed of 0.25 to 0.5 millimeter (0.010 to 0.020 inch) per revolution, according to the size of the chip.

Turning tools for finishing may be fed from 0.1 to 0.25 millimeter (0.004 to 0.010 inch) per revolution.

Cutting-off tools which are very brittle, because very thin to decrease the width of the cut, may be given from 0.05

to 0.075 millimeter (0.002 to 0.003 inch) per revolution.

The feed of forming tools is slowest, according as the shape is more or less complicated, from 0.025 to 0.04 millimeter (0.001 to 0.002 inch) per revolution is good practice.

For drilling with drills of 3 millimeters (0.120 inch) and upward, the feed will be from 0.075 to 0.125 millimeter (0.003 to 0.005 inch) per revolution; below 3 millimeters and down to 1.5 millimeters (0.060 inch) the feed will be from 0.01 to 0.025 millimeter (0.0004 to 0.001 inch), and for deep holes the feed will be reduced at the bottom of the hole. For deep or shouldered counterbored holes, it is preferable to drill a part of the depth with one drill and to finish with another. The drills may be mounted side by side in a double tool holder, one fixed in the drilling head and the other on the slide. The drills for brass are made with straight flute and are less hard than for working iron or steel.

In Zinc—This metal may be worked at the same speed as brass and with the same feeds.

In Semi-Hard Steel—A good steel may be machined with a circumferential speed of 18 to 25 meters (55 to 75 feet) per minute for hollow mills, turning tools with follow rests, cutting-off tools and forming tools.

For tapping and threading, the maximum circumferential speed will be 10 meters per minute (30 feet), and the best results will be attained at a speed of 7 to 8 meters (22 to 25 feet).

The feed to be given to hollow mills may be from 0.15 to 0.2 millimeter (0.006 to 0.008 inch) per revolution.

Finishing tools, when they do not reduce the diameter more than 0.3 millimeter (0.012 inch), may be fed at the same speed as hollow mills, but the feed should be reduced at the end of the cut against the shoulder.

Cutting-off tools may be fed from 0.04 to 0.06 millimeter (0.0016 to 0.0024 inch) per revolution, but the feed should be reduced at the end of the cut.

Forming tools may be fed from 0.03 to 0.07 millimeter (0.0012 to 0.0028 inch).

For drills, the same feed as in brass.

In Soft Steel: This ought to be machined at a circumferential speed not exceeding 18 meters (55 feet) and in tapping between 9 and 12 meters (27 to 36 feet) the feeds may generally be the same as for semi-hard steel.

In Tool Steel: This may be machined at a very high circumferential speed, 12 to 18 meters (36 to 55 feet) per minute, on condition that the feeds be excessively reduced from 0.02 to 0.06 millimeter (0.0008 to 0.0024 inch). For threading and tapping, the speed should not exceed 5 to 7 meters (15 to 21 feet).

In every case, the feed is dependent on the circumferential speed, and while on a lathe, for example, some persons prefer a slow speed and heavy feed, others prefer to turn at a fast speed with a fine feed. In practice we have noticed that it was preferable in small work to turn fast with slow feeds, but the circumstances often require a change of method for different work.

When there are large quantities of work to be machined, it is advantageous not to force production too greatly by increasing both feed and speed, for the time thus gained would be lost by having to sharpen the tools too often.

Laying Out the Cams

The curves which determine the cam are three in number (see Fig. 7): *a* the curve of approach, *b* the curve of work, and *c* the curve of return. The only curve to be determined is *b*, it has the shape either of a circular arc or a special arithmetical spiral, or a combination of the two. It is determined by its length *L* (measured in degrees on the cam plate) and by its pitch *d*, called also "difference" on the cam. It goes without saying that the "difference" on the cam *d*—account being taken of the effect of the levers—determines the length of feed of the tool in the material, and the length *L* of the cam determines the rate of feed, that is to say, the width of the chip (as a function of the speed of the cam shaft).

The approach curve *a* serves to bring the carriage and the tool into position for work. Since this is to be done as quickly as possible, we may give the cam a very steep pitch. Practice has led us to adopt as a suitable curve, one not causing wedging, the curve having a hight $d = 40$ millimeters (1.6 inches) for a length $L = 30$ degrees. The curve of return may likewise be very rapid, and may be a straight line formed by a radius from the center of the cam plate to the point where it meets the curve *b*, but we seek to soften it to avoid the shock that would be caused by too quick a return of the slides.

Responsibility for Good Work

By Entropy

When a sculptor accepts a commission for a statue, he coops himself up in his studio and allows none but his most intimate friends to see it while he is working on it. When a lawyer is retained in a difficult case he withdraws to the seclusion of his private office and only displays the results of his study when it is complete and ready for presentation. When we go to the market and buy cabbages, we examine the vegetable, not the cultivator nor his habits.

On the other hand, when a machinist begins on a job he realizes that he will be judged minute by minute by what he is doing rather than by what he is accomplishing. This is true of all trades to a considerable extent. What we want is the finished work, but we assume that we have a right to criticize the method by which that work is produced.

We want a pair of gears. We order them in a shop which is responsible. We get the gears, put them in place and run them, find them in every way adequate and then turn around and damn the shop they were made in because we found that they were cut on a gear hobber instead of a gear planer.

We have a job of filing to be done, but because the hand that is doing it lays his fingers on top of the file, instead of his thumb, we condemn the job. We see a man laying brick and keeping up with his mates, but the boss happens along and discharges him because his wrist is stiff and he does not have the proper swing and twist. Next thing we know it will be a legal basis for a divorce for the wife to mold bread in any but the way mother used to do it.

This is all nonsensical. It is injuring the trades and preventing progress.

The most wonderful thing about a human being is his power to rise above his physical limitations. I should like to change that classic expression connected with "The saddest words of tongue or pen" from "It might have been" to "It has always been." Why should a man be criticized if he chips a keyway straight and clean and does it quickly, just because he "choked the hammer handle." Why, if he persists in turning his triangles wrong side to in drawing vertical lines, should he be fired if his work comes out right?

The pitiful thing is that the answer is so easily found. Time was when a man who had learned his trade left his master, with perfect confidence that no one knew his trade better than he. If a man questioned his methods he told him his opinion in words of one syllable and invited him to get another man to do his job.

Today our mechanics have no trade. They know that they are set up in front of expensive machines and that they work on expensive material. They dare not say that they will take financial responsibility for damage to machine or material. They are glad to creep in under the protecting wing of a foreman and say, "I will do this job just as you say, and if I smash anything you will have to stand it." What is there elevating about such a trade?

Think of a sculptor who would say to a client, "You get me a block of marble and tell me just what shape you want it, and which side to do first, and how much to knock off the first time over, and what kind of mallet to use, etc., and if you stand over me close enough I will make you just what you want." Think of it!

Would it not be a comfort to go to a machinist and say, "Here is a pile of

castings, here a drawing, there a shop; we want to ship the thing next Monday;" and go off and leave him alone till Monday only to find a machine that you could measure up, and inspect and test, as a whole, as a finished creation and find it right? We all think of that as Utopia and yet we all realize that we never can get to that stage until we place responsibility and authority in equal measure on our workmen.

This brings me to another point. Subdivision of labor necessitates that a master mind should set each of 100 men at work on different parts of the same machine. Competition compels him to also decide how each part shall be made, what jigs are to be used, etc. That in turn compels him to hire not machinists, but operatives. To these operatives what I have written above does not apply. To the men who are really machinists, men who ought to take a part of a machine that is to be made by the hundreds, and build a jig for it, to the men who ought to build the machinery that the operative uses, to the men in engineering shops it does apply. We cannot get men who can be trusted to get results unless we import or make them. Why not make them?

When Cast Iron Shafting Was Common

By F. P. Avery*

The article about the cast-iron line shaft by Y. G. Killian on page 245 has greatly interested me for different reasons. The first is because I have a shop experience which dates back to 1840 when those parties began business.

In March of that year my father came to Tunkhannock, bringing his family and household goods and also tools to partially equip a machine shop. Among and chief of that equipment, was an engine lathe which he had helped build in Cazenovia, N. Y., not far from Pompey, Onondaga county, where he was born and raised.

This lathe had a strong wooden frame on which was a head which could be swiveled so as to bore taper holes. It had a cone and back gears as most engine lathes have, light cast-iron ways for the carriage to slide on, reversible chain feed and a weighted carriage or slide rest as they used to call it. I should guess that the lathe would weigh about 1500 pounds. It would swing 24 inches and as built would take 8 or 9 feet between the centers. It has since been lengthened. It was put into a shop as soon as one could be built and has remained on the premises until now. Our town is 30 miles from Wilkesbarre and 40 from Towanda and that lathe did duty for the unoccupied territory between for a long term.

Had the parties in Zanesville possessed as good a lathe there would have been no trouble to turn the bearings on the 9-inch shaft. The lathe did duty there for 25 years, doing the jobs that came to the shop before any other or larger one was procured. A lathe that could do all of those things for such a length of time was, to use an old-time expression, "not to be sneezed at."

Father ran that shop until 1850 and sold it to buy a farm. The man who bought it is now dead and the old lathe and other quaint tools stand idle but the belt is on it yet all ready for a resurrection. Father had a foundry also as soon as one could be built, which he at first rented to a party who began the making of stoves which were displacing the old-time fireplaces. The lessee did not find the venture profitable and soon departed. Father then began the making of castings.

The Use of Cast Iron in Mills

All along this north branch of the Susquehanna river where creeks joined the river saw and grist mills had been and were being built, and cast iron was used in their construction, almost to the exclusion of wrought iron. I realized this fact more fully and clearly from the few years' experience when many of these mills have given way to modern structures or been abandoned, and the old castings come to my shop as No. 1 scrap and very little wrought with it.

This old scrap is interesting and tells its own story. Some, I may say many, of the shafts were square, having certain places cast round which greatly saved work in turning, and the square part was easy to fit wood pulleys to. Vertical spindles which drove the millstones were often six-sided and tapered and had a cast pinion cored to fit. These pinions were lifted up off the shaft and out of mesh with the driving gear when the stones were not in use.

To my mind that six-sided fit has never been bettered. The old machinist fitted it for one position only, as they do now when it fits a feathered-tapered round spindle. None of the round shafts were turned where there was no bearing nor wheel to be fitted. He seemed to dread lathe work.

The Cost of Transportation

When I mention the year 1840, I remember a very small boy, but about the middle of that decade when father was operating his own foundry, I was looking on and observing, running errands and waiting on the men generally. There was an iron furnace down the river, at Shickshinny, where iron was made, and that was the base of his supply. He would send a hired team and they would bring back one ton of slender pigs after a three days' absence. The cost of transportation was not so very much more than I now pay per ton from Catasauqua. This was charcoal pig, was very soft and strong, bending before it would break.

A decade later, excellent anthracite iron was made at Bloomsburg, which was the source of supply for this and other towns along the river.

Straightening a Cast-iron Shaft

Some of the shafts among the scrap mentioned were as small as 2½ inches and as long as 8 or 9 feet, and the largest not more than 8 inches and none of them over that length. The old-time mills are fast passing away or being remodeled and new devices for milling going into the old structures. I know of less than a half dozen now in commission. There is one not three miles from here that has a vertical-cast shaft over 10 feet long and 3½ inches in diameter, which at one time came to my shop badly bent and which the millwright ordered turned down to straighten it.

I told the owner who brought it, that I could straighten it, which I proceeded to do by springing it hard and peening it on the hollow side with a light hammer. He soon went on his way rejoicing, but the millwright was displeased because I did not do as I was ordered, and in putting it in place he sprung it out again so that it did not run true. How or why I can't imagine. The owner told how I straightened it, and he proceeded to pound it with a sledge as if it were wrought iron. He injured instead of bettering it, and a few days later I called and made it run true. It ran many years after and is there today; idle because a flood took away the dam.

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It is pointed out by the *American Engineer and Railroad Journal* that the recent action of a prominent Eastern railroad in reverting to the use of engine oil for pin and journal lubrication, after two or three years' practically exclusive employment of grease, constitutes a move of general interest in view of the fact that the latter compound has become so generally adopted in every branch of locomotive service, and has proved so largely exempt from complaint or criticism. In the specific case to which reference is made there was no fault to find with the grease failing in its appropriate business as a lubricant, as the records of the motive power department in question are said to indicate a decreased number of hot bearings over the period when oil was in universal use, but the reason advanced for its abandonment is the increased wear of bearings under grease lubrication. One crank pin showed a wear between shoppings of 3/16 inch on grease, and a reduction of ⅛ inch in the nominal diameter of these parts was not uncommon.

Materials Used in Motor Cars

By J. Coapman

The specifications that are drawn up by three prominent automobile builders for the purchase of rolled or forged steel, steel castings, malleable or cast iron, aluminum, bronze, brass, and babbitt or bronze bearing metals.

The heat treatment that is given the various steel parts that enter into the automobile and are made of the steels herewith specified.

The matter of design of an automobile is becoming standardized to a great extent. In fact, so great is the tendency in this regard that we sometimes hear the question: "Why is such a car better than that one? They look alike and first-class workmanship is claimed for each, and yet there is quite a difference in the price asked." The reason is, no doubt, due to the grade of materials used. Some makers will usr nothing but the very best that can be obtained, while others use materials that they consider good enough. Materials are of a higher quality today than they were two years ago.

I have in mind three makes of cars. One is considered one of the best produced in this country, and has the price set accordingly. Another is produced in enormous quantities, sold at a popular price, and seems to be giving satisfaction. And the third one is in a class between these two. I will, therefore, give their specifications for materials and the heat treatments given the steel.

Steel Specifications of the E. R. Thomas Company

The E. R. Thomas Company, of Buffalo, probably has about as complete a set of material specifications as exists. They give specifications for practically all the materials used by them.

Cap screws, studs and nuts are made of an open-hearth steel of the following analysis, which is designated C. S. 3:

Carbon	0.24 to 0.35 per cent.
Manganese	0.50 to 1.00 per cent.
Sulphur	0.05 per cent. or less
Phosphorus	0.05 per cetn. or less

In a few cases they specify nickel steel.

Crank shafts are generally specified as nickel steel of the following analysis, though the final choice of the material and its treatment is usually left to the forge company. It is designated N. S. 1:

Carbon	0.18 to 0.28 per cent.
Manganese	0.60 to 1.00 per cent.
Nickel	3.00 to 3.75 per cent.
Sulphur	0.04 per cent. or less
Phosphorus	0.04 per cent. or less

Copper must be less than 0.02 per cent.

In some instances a steel of lower carbon content is preferred for pack hardening and general use. Its symbol is C. S. 2, and the chemical analysis is as follows:

Carbon	0.14 to 0.24 per cent.
Manganese	0.50 to 1.00 per cent.
Sulphur	0.05 per cent. or less
Phosphorus	0.05 per cent. or less

Nonferrous Metals

When manganese-bronze castings are required, the following analysis, which is called M. B. 5, is specified: Copper, 56.36 per cent.; zinc, 39.79 per cent.; tin, 1 per cent.; iron 0.24 per cent.; aluminum, 0.52 per cent.; manganese, 0.40 per cent.

For bearings and general use where phosphor bronze is required their P. B. 7 is used, and the following analysis is specified: Copper, 88.60 per cent.; tin, 10 per cent.; lead, 1 per cent.; phosphorus, 0.40 per cent.

For brass gears their G. B. 8 of the following analysis is used: Copper, 88 per cent.; tin, 10 per cent.; zinc, 2 per cent.

Where brass castings are required the analysis below is recommended, and is called A. B. 9: Copper, 80 per cent.; zinc, 15 per cent.; tin, 4 per cent.; lead, 1 per cent.

For crank cases, transmission gears, and in general wherever it is necessary to specify aluminum alloy they recommend the following analysis, called A. L. 12: Aluminum, 92 per cent.; copper, 7 per cent.; zinc, 1 per cent.

Heat Treatments

Nickel steel 1 and carbon steel 2 when used for transmission gears, are heat-treated as follows, under the symbol T-1: Pack harden, allow to cool in pot, reheat to from 1375 to 1425 degrees Fahrenheit and quench in oil.

When the steel is used for parts that are to be glass hard and are not subjected to any great strains, heat-treatment T-2 is given them. This only differs from T-1 in that water is used for quenching instead of oil.

When used for bevel-drive gears and pinions or differential pinions, heat treatment T-3 is used as follows: Pack harden, allow to cool in pot; reheat to from 1375 to 1425 degrees Fahrenheit and quench in oil. Then draw at from 375 to 425 degrees.

Nickel steel 1 and carbon steels 2 and 3, when used for small, thin parts that are to be case hardened, are given T-4 heat-treatment. This is, heat in cyanide and quench in oil.

When used for any large work or local case hardening they are given T-5 heat-treatment. This is, heat in cyanide and quench in water.

Nickel steel 1, when used for propeller shafts and the semi-floating type of axle-drive shaft, or where bending and torsion is to be resisted, must be given T-6 heat-treatment as follows: Heats to from 1575 to 1625 degrees Fahrenheit and quench in oil; or T-7, which is, heat

In Annealed State.	Elastic Limit. Pounds per Square Inch.	Ultimate Strength. Pounds per Square Inch.	Percentage of Elongation.	Reduction of Area in Percentage.
Nickel steel 1	60,000	80,000 90,000	30	65
Carbon steel 2	27,000	50,000	25	60
Carbon steel 3	33,000	60,000 66,000	23	50
Heated to 1550 degrees F., quenched in oil, and drawn at 600 degrees.				
Nickel steel 1	135,000	200,000	15	50
Heated to 1,500 degrees F. and quenched in brine.				
Nickel steel 1	170,000 180,000	230,000 240,000	11–12	40–45
Heated to 1,450 degrees F. and quenched in oil or water.				
Carbon steel 2	27,000 32,000	65,000	15	40
Carbon steel 3	33,000 37,000	72,000	12	35

Note.—For shear or torsion use values that are 80 per cent. of the above. The above values are all right for compression.

to from 1575 to 1625 degrees and quench in water; or T-8, which is, heat to from 1575 to 1625 degrees and quench in brine.

When the carbon goes above 0.32 per cent., T-6 is used, and when below, T-8 may be used. T-8 is also used for floating drive shafts where pure torsion is to be restricted. Never quench semi-floating type of axle driving shafts in brine.

Nickel steel 1 and carbon steel 3, when used for steering knuckles, steering arms, front and rear axles and spring chains are given T-9 heat-treatment. This is, heat to from 1475 to 1525 degrees Fahrenheit and quench in oil, then draw at from 475 to 525 degrees; or T-10, which is, heat to from 1475 to 1525 degrees and quench in oil.

All nickel-steel cap screws are heated to from 1400 to 1500 degrees Fahrenheit and plunged in oil. They are then drawn at from 700 to 800 degrees.

Nickel steel 1 and carbon steel 2, when used for clutch drives, steel clutch plates, etc., are given T-14 heat-treatment. This consists of pack hardening, allowing to cool in the pot, and afterward reheating to from 1375 to 1425 degrees Fahrenheit and quenching in brine.

All nickel-steel tubing, after brazing, is given T-15 heat-treatment, which is; heat to from 1375 to 1425 degrees Fahrenheit and quench in oil at from 60 to 100 degrees. Afterward draw at from 600 to 650 degrees.

Strength

The physical properties of the above steels are as follows:

Gears

For heat-treating gears where it is necessary to increase their strength without increasing the size, the following treatment is used when they are made of 3½ per cent. nickel steel: Pack harden at 1650 degrees Fahrenheit until the carbon has penetrated a trifle over 1/64 of an inch and allow the work to cool in the pot. Then reheat to 1500 degrees very slowly and quench in a salt solution at 125 degrees. After this reheat rapidly with a very hot fire to the lowest point at which steel can be hardened, which is from 1325 to 1350 degrees.

When pack hardening it, it is best to use 40 per cent. of new and 60 per cent. of old bone. Consume three hours in raising the temperature of the steel up to the carbonizing temperature of 1650 degrees and then allow it to soak for three hours. It is well to add charred scrap leather to the bone supply from time to time. Carbon penetrates 3½ per cent. nickel steel, about 1/64 of an inch deep, in two hours.

Stock for keys should be a high-grade steel that contains 0.80 per cent. of carbon. It should be hardened in oil or water at 125 degrees Fahrenheit.

E. M. F. Company's Specifications

The E. M. F. Company is one of the largest producers of automobiles. They own, lease or control practically all of the different plants that manufacture their parts. They have one of the largest drop-forge plants in the country and also operate a fair-sized pressed-steel plant.

Under these conditions it is necessary that they have a uniform set of specifications to cover all materials used. To that end they have adopted the decimal limit gage in the following table:

Birmingham or Stubbs Iron Wire. B. W. G.		Decimal-Limit Gage.	American or Brown & Sharpe. B. & S.	
No.	Inch.		No.	Inch.
35	0.005	0.005 ± 0.00025	36	0.005
31	0.010	0.010 ± 0.0005	30	0.010025
28	0.014	0.015 ± 0.001	27	0.014195
27	0.016	1/64—inch	26	0.01594
25	0.020	0.020 ± 0.001	24	0.0201
23	0.025	0.025 ± 0.001	22	0.025347
22	0.028	0.030 ± 0.0015	21	0.028462
21	0.0302	1/32—inch		
20	0.035	0.035 ± 0.0015	19	0.03589
		0.045 ± 0.002	17	0.045275
		1/22—inch		
		0.055 ± 0.002	15	0.057068
16	0.065	0.065 ± 0.0025	14	0.064084
		1/16 + inch		
15	0.072	0.075 ± 0.003	13	0.071961
14	0.083	0.085 ± 0.003		
13	0.095	0.095 ± 0.004	11	0.090742
		3/32 + inch		
12	0.109	0.110 ± 0.004	9	0.11443
		7/64 + inch		
11	0.120	0.125 ± 0.005	8	0.12849
		1/8 inch		
		0.140 ± 0.005	7	0.14428
		9/64—inch		
		0.155 ± 0.005		
		5/32—inch		
8	0.165	0.170 ± 0.005		
		11/64—inch		
7	0.180	0.185 ± 0.005	5	0.18194
		3/16—inch		
6	0.203	0.200 ± 0.005	4	0.20431
		13/64—inch		
5	0.220	0.215 ± 0.005		
		7/32—inch		
		0.230 ± 0.005	3	0.22942
		15/64—inch		
		0.250 ± 0.005		
		1/4 inch		

It will be seen that it is possible for the manufacturer to sometimes substitute material of one gage for the other and still come within the limits set by the company. This greatly facilitates matters for the purchasing department, as it was often found that it was hard to obtain material of either Brown & Sharpe gage or the Birmingham gage. If the latter were specified possibly the former would be the only one obtainable and *vice versa.*

Carbon Steels

For pump, cam shaft or transmission gears, secondary shafts, etc., they use a carbon steel with an analysis as follows:

Carbon	0.30 per cent.
Manganese	0.70 per cent.
Silicon	0.06 to 0.08 per cent.
Sulphur	under 0.04 per cent.
Phosphorus	0.025 per cent.

The heat-treatment given this steel is as follows: After forging heat to from 1550 to 1600 degrees Fahrenheit and allow to cool. Then re-heat to 1500 degrees and quench in oil at from 60 to 90 degrees. When cold, again re-heat to from 850 to 900 degrees and allow to cool slowly.

A little better quality of carbon steel is specified for valves, connecting rods and axles. The analysis of this is:

Carbon	0.30 to 0.40 per cent.
Manganese	0.60 to 0.80 per cent.
Silicon	under 0.06 per cent.
Sulphur	under 0.04 per cent.
Phosphorus	under 0.04 per cent.

The heat-treatment given it is: After forging heat to from 1550 to 1600 degrees Fahrenheit and allow to cool. Then re-heat to from 1450 to 1500 degrees and quench in water at from 60 to 90 degrees. When cold again re-heat to from 850 to 900 degrees and allow to cool slowly.

Transmission gears and countershafts require a steel of lower carbon content and for this purpose they specify the following:

Carbon	0.20 to 0.28 per cent.
Manganese	0.60 to 0.75 per cent.
Silicon	under 0.08 per cent.
Sulphur	under 0.04 per cent.
Phosphorus	under 0.04 per cent.

Its heat-treatment is; anneal the forgings and carbonize 1/32 of an inch deep, after machining.

Crank shafts require a very high grade of material and also careful heat-treatment. Some manufacturers use a 3½ per cent. nickel steel for this purpose, but they are few in number. For various reasons the E. M. F. Company prefers a carbon steel of the following analysis:

Carbon	0.35 to 0.45 per cent.
Manganese	0.65 to 0.80 per cent.
Silicon	under 0.06 per cent.
Sulphur	under 0.03 per cent.
Phosphorus	under 0.03 per cent.

The heat treatment is the same as that given immediately above for the steel used for valves, connecting rods and axles.

Nickel and Vanadium Steels

Sanderson's 3½ per cent. nickel steel is specified for bevel gears and pinions and also the differential pinions. The analysis, as furnished by the makers, is:

Carbon	0.18 to 0.26 per cent.
Manganese	0.75 to 1.00 per cent.
Nickel	3.50 per cent.
Silicon	under 0.06 per cent.
Phosphorus	under 0.04 per cent.
Sulphur	under 0.04 per cent.

The heat treatment for this is: heat to from 1500 to 1550 degrees Fahrenheit and quench in oil from 60 to 90 degrees. When cold reheat to 1350 degrees and anneal.

Propeller shafts also require a very high grade of steel and for this purpose

that made by the United States Steel Company and known as "Type K" is used.

Its analysis is:

Carbon	0.25 to 0.35 per cent.
Manganese	0.50 to 0.60 per cent.
Chromium	0.30 to 0.40 per cent.
Silicon	0.06 to 0.075 per cent.
Vanadium	trace
Phosphorus	0.04 per cent. or less
Sulphur	0.04 per cent. or less

This has been heat treated when purchased and is ready for use.

On the regular model they use a silico-manganese steel for all frame members and its analysis is as follows:

Carbon	0.25 per cent.
Manganese	1.50 to 2.00 per cent.
Silicon	0.75 to 1.00 per cent.
Sulphur	0.035 per cent. max.
Phosphorus	0.035 per cent. max.

Its physical properties are:

Annealed.		Heat-treated.
120,000	Tensile strength	160,000
80,000	Elastic limit	120,000
15%	Elongation in 2 inches	10%
40%	Reduction in area	30%

A. L. A. M. Specifications

The third builder insures himself against defective material by specifying the analysis recommended by the A. L. A. M. and then tests portions of each shipment received in his own laboratory.

Drop-forged and rolled steels are subject to the following specifications: Steel may be open-hearth or crucible manufacture.

It must be free from such physical defects as seams, pipes, hot or cold shuts, scabs, or surface cracks.

It must be in good physical condition as received. This condition will be judged from a fresh fracture. A fracture showing a coarse crystalline and burned structure may cause the rejection of the bar. Should several bars show such a fracture the entire lot may be rejected.

In accepting an order, it is understood that representatives of this company may have access, for purpose of inspection, to such portions of the works as this material may pass through during manufacture.

Forgings

Crank shafts are drop forged of steel symbolized M 2, and those not conforming to the following chemical analysis may be rejected:

Carbon	0.23 to 0.33 per cent., 0.28 per cent. preferred.
Manganese	0.50 to 0.70 per cent., 0.60 per cent. preferred.
Phosphorus	not to exceed 0.04 per cent.
Sulphur	not to exceed 0.04 per cent.

The T-1 heat-treatment is given them as follows: Heat to from 1450 to 1500 degrees Fahrenheit and quench in oil below 100 degrees, unless otherwise specified. Then heat to from 800 to 1000 degrees and cool slowly in the furnace.

Crank-shaft gears are made from the same steel as the crank shafts but they are untreated.

Connecting rods, crank shafts and rear axle-clutch hubs are also made of this same material but they are given the following heat treatment. Carbonize at 1700 degrees Fahrenheit and cool slowly. Then heat to 1450 degrees and quench in oil below 100 degrees, unless otherwise specified. After this draw at 325 degrees in hot oil and cool slowly.

Transmission and rear-axle gears are treated the same way except that the screw end is afterward drawn at 1200 degrees.

Valves must have a nickel-steel head, that is designated by the symbol M-3, and a carbon-steel stem.

Nickel Steel

This nickel steel must be of the following chemical analysis, or it may be rejected:

Carbon	0.20 to 0.30 per cent., 0.25 per cent. desired.
Nickel	3.20 to 3.60 per cent., 3.40 per cent. desired.
Manganese	0.50 to 0.70 per cent., 0.60 per cent. desired.
Phosphorus	not to exceed 0.04 per cent
Sulphur	not to exceed 0.04 per cent

The heat treatment given it is as follows: Heat to 1500 degrees Fahrenheit and quench in oil below 100 degrees, unless otherwise specified. Also dip in cyanide or quench in water to harden.

Transmission secondary shafts receive the following treatment: Carbonize at 1700 degrees Fahrenheit and allow to cool slowly. Reheat to 1500 degrees and quench in oil below 100 degrees, unless otherwise specified. Again reheat to 1380 degrees and quench as before, afterward drawing at from 325 to 350 degrees.

All coiled springs are made of open-hearth or crucible-made steel that is marked M-7.

If not conforming to the following chemical analysis it may be rejected:

Carbon	0.95 to 1.10 per cent., 1.00 per cent. desired
Manganese	not to exceed 0.35 per cent.
Silicon	0.10 to 0.30 per cent.
Phosphorus	not to exceed 0.03 per cent.
Sulphur	not to exceed 0.03 per cent.

Its heat treatment is: Heat to 1450 degrees Fahrenheit and quench in oil below 100 degrees, unless otherwise specified. After this draw at from 500 to 600 degrees in hot oil and cool slowly.

Steel Castings

When it is necessary to use steel castings the following will apply: Material to be of open-hearth or crucible steel. Castings must be true to pattern and free from blow holes or shrinkage cracks.

Surfaces that are to be machined must not show blow holes that in any way affect the possibility of making a machine fit or that are of sufficient extent to weaken the casting.

For low-carbon steel castings the following chemical analysis is specified:

Carbon	0.30 to 0.40 per cent.
Manganese	0.60 to 0.80 per cent.
Silicon	0.10 to 0.30 per cent.
Phosphorus	not to exceed 0.06 per cent.
Sulphur	not to exceed 0.06 per cent.

Sometimes it is necessary to specify high-carbon steel, which is covered by the following specification: Steel of open-hearth or crucible manufacture; must be free from such physical defects as seams, pipes, hot or cold shuts, scabs or surface cracks; must be in good physical condition as received. This condition will be judged from a fresh fracture. A fracture showing coarse crystalline and burned structure may cause the rejection of the bar. Should several bars show such a fracture, the entire lot may be rejected.

High-carbon steel castings should be of the following analysis:

Carbon	0.75 to 0.90 per cent., 0.85 per cent. desired
Manganese	not to exceed 0.50 per cent.
Copper	not to exceed 0.40 per cent.
Phosphorus	not to exceed 0.03 per cent.
Sulphur	not to exceed 0.03 per cent.

Cast Iron

Cam-shaft gears, cylinders, pistons, etc., are of cast iron of the following specifications: Castings received under these specifications will be submitted to physical examination and chemical analysis. Castings containing blow holes, shrinking defects or showing chill at points that must be machined, may be rejected. Castings must be accurate, true to pattern and the location of the core must be given special attention.

The iron must be of the following composition:

Total carbon	3.20 to 3.60 per cent.
Silicon	1.90 to 2.20 per cent.
Manganese	0.40 to 0.70 per cent., 50 per cent. preferred.
Phosphorus	0.70 to 1.00 per cent.
Sulphur	not to exceed 0.10 per cent.

The gray iron used for piston rings may run higher in sulphur than the above specification, but must not exceed 0.15 per cent.

Aluminum

Crank cases, transmission cases and all aluminum castings are covered by the following specifications: Castings received under these specifications will be inspected. Sample castings will be taken from each shipment for chemical analysis and physical test.

Fractures showing the presence of oxides by discoloration will be rejected. If a number of castings, when broken, show this defect, the lot may be rejected.

Metal not falling within the following chemical analysis may be rejected:

Aluminum	93 to 95 per cent., 94 per cent. desired.
Copper	5 to 7 per cent., 6 per cent. desired.

Other elements in excess of 0.5 per cent. of any one element, may cause the rejection of the castings. This particularly applies to iron, silicon or carbon. The tensile strength of the metal must be at least 15,000 pounds per square inch as determined by a bar cut from a casting.

Bearing Metals

Bearings that are not of the ball-bearing type are usually made of die castings

or of phosphor bronze of the following analysis:

Bearing babbitt die castings; castings received under the specifications will be inspected physically and chemically.

Broken castings must show freedom from oxides as indicated by discolored areas. The size of the crystals seen at the fracture must be reasonably small; indicating cooling sufficiently quick to prevent segregation of the elements. Slow cooled castings resulting in very large crystals may cause the rejection of the material.

Castings not coming within the following chemical analysis may be rejected:

Tin	86 to 88 per cent.
Antimony	6 to 8 per cent., 7 per cent. desired.
Copper	3 to 5 per cent., 4 per cent. desired.

Phosphor bronze: This metal furnished in castings or in bar form must be free from physical defects.

A fresh fracture must show clean metal. Presence of blow holes or discoloration by oxides may cause the rejection of the bar. Should such appearance be found in several fresh fractures, entire shipment may be rejected.

Metal not falling within the following analysis may be rejected:

Copper	82 to 86 per cent., 84 per cent. desired.
Tin	7 to 9 per cent., 8 per cent. desired.
Lead	6 to 8 per cent., 7.5 per cent. desired.
Phosphorus	0.2 to 0.6 per cent.,0.4 per cent. desired

Malleable Iron

In some instances it is necessary to use malleable iron and then the following specifications apply:

Castings received under the specifications will be inspected both physically and as to composition.

One or two castings will be taken from each shipment for physical test.

The test will consist of striking with a hammer to determine the toughness of the metal.

The character of the metal must be such as to permit considerable distortion before rupture.

Castings that break without distortion will be rejected.

The fracture must be noncrystalline and characteristic of well annealed malleable iron.

All metals not within the following chemical analysis may be rejected:

Silicon	0.50 to 1.00 per cent.
Manganese	0.30 to 0.60 per cent
Phosphorus	not to exceed 0.20 per cent.
Sulphur	not to exceed 0.06 per cent.

In conclusion we might add that practically every engineer has his own material specifications. These may possibly differ slightly from those given above, but it is believed that the specifications given are representative for the class of cars built by these three companies. They each have their own chemical and physical laboratories and the specifications are what they consider are practical for the material desired.

Making Front Axles

After the front axles have been forged under the drop hammers to secure the necessary section and to shape the ears for the steering knuckles, they are then taken to the large forging press shown at the left and bent to the required shape by the large cast-iron dies shown.

They are then ready to be finished both for the steering knuckles and the spring hanger, and Fig. 2 shows the machine used in plant No. 3 of the E-M-F company in which the Flanders cars are built. This is an especially designed milling machine by the Espen-Lucas company and handles two axles at one setting by the use of the double gang of milling cutters shown beyond the supporting arm at the right. The holding fixtures are so made that the axles can be readily put in and taken out, and a bright boy can handle a large number of these during a working day.

Beyond the milling machine is a gang of special drilling machines in which the holes are drilled for the steering knuckles, the axles being held, in suitable fixtures. This reduces the amount of handling necessary on these axles, as all the operations are performed by machines located as closely together as possible.

Fig. 1. Curving the Front Axles

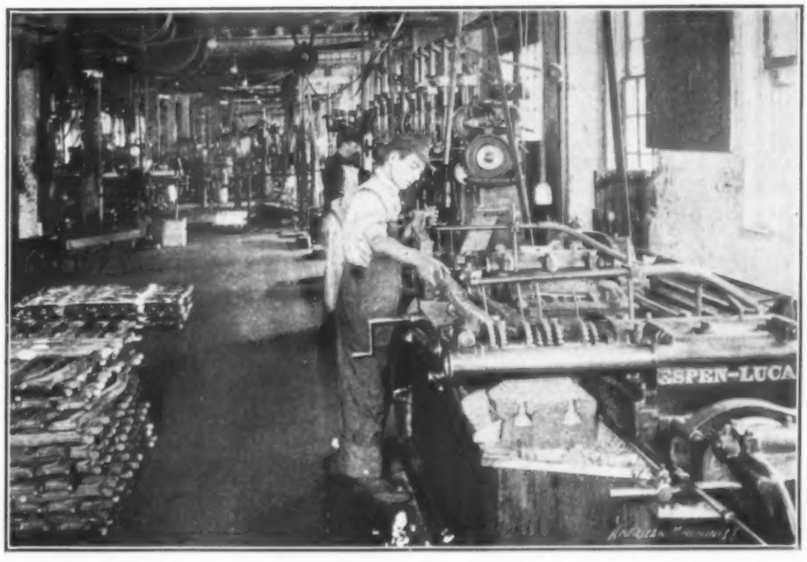


Fig. 2. Milling Axle Ends for Steering Knuckles

We often hear in lectures on astronomy, of stars so far away that the light which they send to us must have started from them 300 years ago. As light travels at the rate of 186,000 miles per second, this means that the distance to such a star is 1,759,708,800,000,000 miles! This is almost 20 million times the distance from the earth to the sun, the light from which requires about eight minutes to reach us.

Press Tools for an Oval Pan

By M. Martin

A set of dies that receive the formed shell for a roasting pan after the handles have been riveted in place, and accomplish the wiring of the edge, and "reverse" the shell in an inside-out drawing operation.

An unusual die construction shown in various stages of operation, to enable a peculiarly shaped receptacle to be economically produced in the press.

Some time ago I had the pleasure of designing a complete outfit of tools for a new style oval-shaped roasting pan, where the outside jacket and the pan itself were drawn in one piece, in place of "heading" the pan over the jacket as heretofore.

At the start I did not consider the pan a very serious proposition, but during the designing of the tools for the various operations, there developed some very peculiar features in connection with the operations, and when the two handles were to be attached and in the false wiring or curling of the lower edge when finished.

Fig. 1 represents the top view of the finished pan, and Fig. 2 the side view. It will be noticed that the handles as attached are in a specified position in relation to the top of the pan, and as we had no uptodate welding apparatus to weld them to the outside of the pan after it was finished, the body had to be perforated and these handles riveted on. It will also be noticed that the space in the finished article between the outer jacket and the pan itself is only ¼ inch, and this small space made it imperative that these handles be riveted in position before the shell was reversed.

The False Wiring Proposition

After the handle proposition had been disposed of, the false wiring of the bottom was next in order, and in my original layout I decided to make this a separate operation. In other words, the method of procedure was to reverse the shell with the handles attached in the usual double. action inside-out fashion, and then to false wire or curl the raw edge in a split ring wiring die in a single-acting press; this method necessarily would have required two presses, two sets of dies and two distinct and somewhat expensive operations. This did not appeal to me from the very start, and I finally effected a combination of the two which finished the pan in one operation, and the result was what we might call a "single-action double-action" die, that in its action is quite unique, as in the first part of the action of the double-action press, the pan is false wired, and then the shell reversed, insuring a straight or flat curled edge or base.

Fig. 3 represents the shell prepared for this operation, that is, it is trimmed, perforated, and the handles riveted in position.

The Die Construction

Fig. 4 represents a side view of the parts of this die. *A* is a cast-iron shoe or bolster, with a ledge on the inside at *A*-1, and a seat turned in the top face *A*-2, in which is inserted the steel ring *B*. This curling ring *B* is made of tool steel, and has a curling groove *B*-1, which is exactly one-half of a true circle of the size of the curl required and is turned up close to the inside edge to almost a knife edge. *C* is a movable tool-steel sleeve or shell fastened to a cast-iron base *C*-1, and acts as a support to the pan shell in the first part of the action, and prevents it from collapsing, in false wiring, and then, resting on the bottom of ledge *A*-1 acts as an inside-out die. This is supported by strong spiral springs in pockets as at *C*-2, which raise this up against the lower side of curling ring *B*, so that the pan shell to be false wired and reversed is always clear of the curling groove before the die is in action. *D* is a cast-iron pad which ejects the shell after it has been reversed, and incidentally smooths out any wrinkles in the bottom caused by the previous operation.

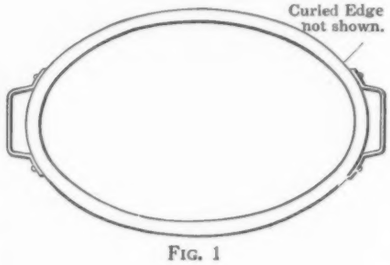


Fig. 1

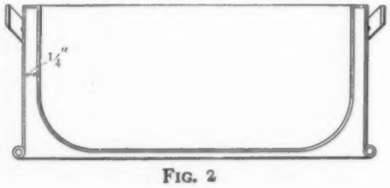


Fig. 2

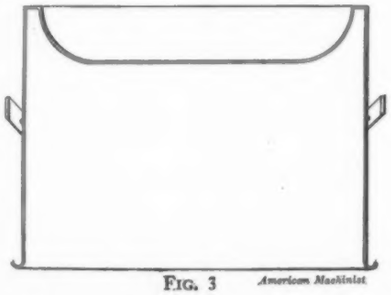


Fig. 3 *American Machinist*

The Pan and the Evolution

The Blank Holder

E is the double-action blank holder, which in action has a double purpose. The peculiar construction will be noticed. *E*-1 is a cast-iron shoe in which is secured the tool-steel ring or sleeve *E*-2, which is machined on the inside at *E*-3 to the exact size of shell to be reversed, and has a shoulder *E*-4 against which this shell butts, and which in curling acts as a punch, and in reversing as an ordinary double-action blank holder. This sleeve at the lower end *E*-5, is opened out to the exact size of the false wiring, and the distance between *E* 4 and the shoulder at *E*-5 plus the diameter of the curl, is the outside hight of the finished pan.

In connection with this sleeve there are four slots or openings *E*-6, marked respectively, *a*, *b*, *c*, *d*, cut through almost to shoulder *E*-4, which provide clearance for the handle as riveted to the shell. Also the outside wall of this sleeve *E*-7 is machined small enough to pass inside the loop of the handles, so as not to disturb them. *F* is the regular double-action punch or plunger, which after the blank holder *E* has curled the lower edge of the shell in connection with ring *B* and forced *C* to the bottom ledge in *A*, redraws the shell, and upon the completion of the action, the pan is raised to the top of *C* by pad *D*, and is ready to be lifted off by the operator.

Fig. 5 is a more comprehensive view of blank holder *E*, and shows all the features more clearly.

Other Features

Fig. 6 represents the position of the shell in the die with the handles attached in position to be false wired.

Fig. 7 represents the position of the shell after being false wired and ready

to be reversed. Note how all the parts *A*, *B*, *C*, *E* are in action.

Fig. 8 represents the position of the shell at the completion of the action (the shell being redrawn or reversed) and also shows the positions of *F* and *D*.

Fig. 9 represents the position of the shell at the finish of one complete revolution of the press, with all the parts disengaged, and the finished pan in position to be removed by the operator.

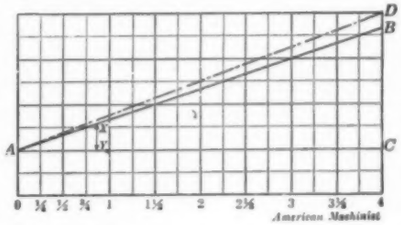
The action of the die in operation is ideal, and it is a pleasure to watch the pans being finished in this manner.

It should be stated that to more fully illustrate various features in connection with the pan and the component parts of the die, the sketches have not been held to any stated reduction in size in conformity with the actual pan or die, which as shown are entirely out of proportion; also for the same reason the locations of small minor parts in the construction of the die, such as screws, etc., have been omitted.

Laying Out Drawings to Irregular Scale

By Designer

The device shown herewith was found very useful some time ago, when I had some small drawings to make to the scale of ⅔ to 1. Having no scale at hand of these proportions, I proceeded to construct one in the manner shown. Taking cross-section paper, ruled with ⅛-inch squares, lay off a line *A C*, any convenient length; at the end of this line, erect a perpendicular *B C*, equal to say 4 inches on a scale of ⅔ to 1, or 2.66 inches, and draw the line *A B*. Line *A C* is then made to represent the original 4 inches and correspondingly divided into inches, halves, quarters, eighths, etc. Distances measured from these points to corresponding points on *A B*, on the perpendicular lines of the cross-section paper, will represent the divisions on *A C* to the ⅔ to 1 scale. These distances may be spaced off directly with the dividers; for instance, ⅞ inch to a ⅔ to 1 scale will equal the distance *X Y*.



Drawing to an Odd Scale

This scale may be constructed to any proportions needed in the same manner; as, for instance, the line *A D* shows the scale of ¾ to 1, the line *C D* being in this case, 3 inches long.

It is said that in a self-balancing aëroplane, invented by J. F. Cooley, it is proposed to use compressed air, not only for starting the motor, but to keep it going long enough in case of failure of ignition or gasolene to prevent the serious accidents which have occurred from this cause in the past.

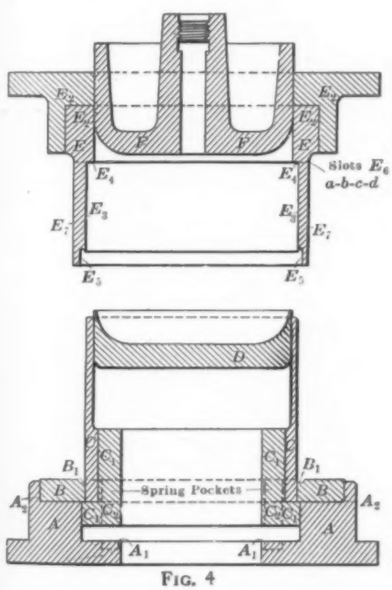


Fig. 4

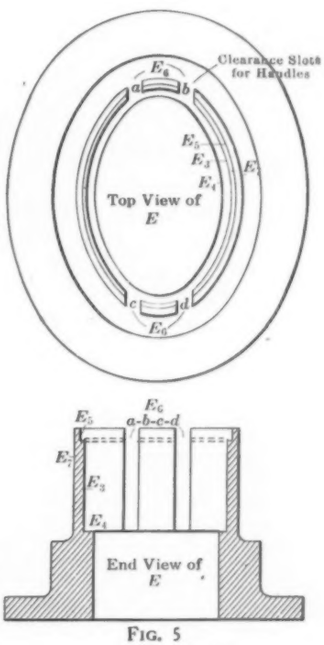


Fig. 5

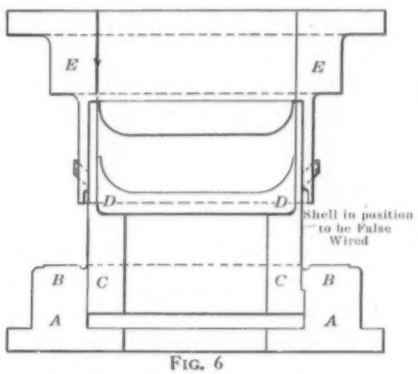
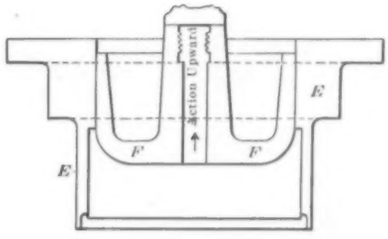


Fig. 6



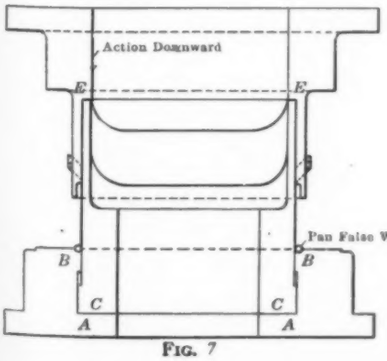


Fig. 7

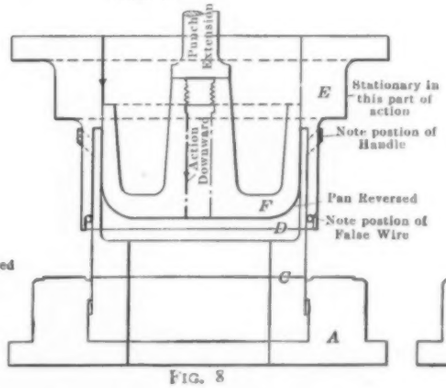


Fig. 8

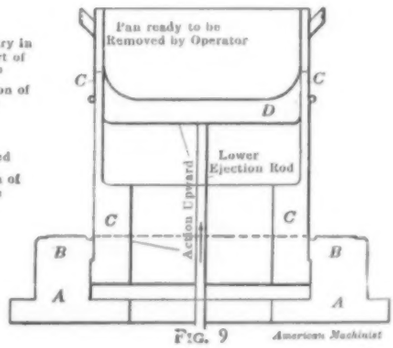


Fig. 9

Press Tools for an Oval Pan

Improving the Grinding Machine

By J. Mahon*

It seems as if the present-day designing is done with the mistaken idea, that on account of the short life of some parts of grinding machines, it is necessary to construct them as cheap and simple as possible in order that they can be repaired easily.

I would point out the fact that if it is desired to increase the life and value of grinding machinery to any extent, it is necessary to make all parts adjustable for wear; using bronze boxes and hardened tool-steel spindles for all work and grinding spindles and taking extra precaution to exclude the dust from bear-

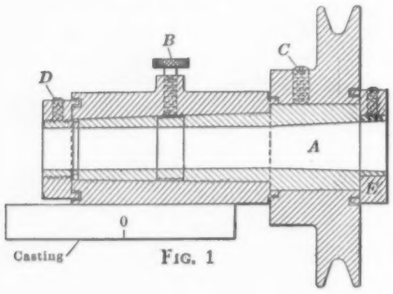


Fig. 1

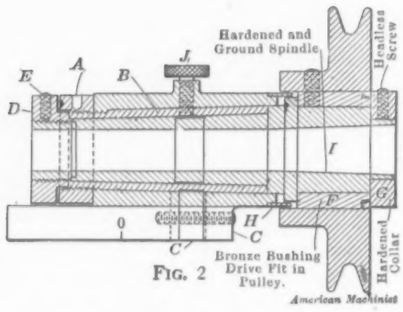


Fig. 2

Before and After Improving

ings, which can be done by providing suitable dust caps.

A grinding machine that is worn and has no adjustment is useless as a finishing machine on a commercial basis.

I will show a couple of improvements I have made on two different makes of universal machines of the smaller type.

Fig. 1 is a cross section of the headstock as built. It will be noticed the construction is such as to allow spindle *A* to rotate, or by tightening thumb screw *B* and loosening set screw *C*, can be used as a dead center using pulley *D* to rotate work on centers. *E* is a soft-steel collar.

A chuck and face plate having a No. 7 Brown & Sharpe taper shank, is used in the taper hole in spindle *A*.

We used this headstock, rotating spindle *A* on an average of an hour per day and at the end of about a year it was neccesary to repair it. This was done as in Fig. 2, using the same casting and pulley. Although the space for an adjustable bearing is very limited it proved very satisfactory.

A is the adjusting nut for bronze box *B*, *C* is the locking arrangement to prevent a slight jar on end of spindle from pushing box *B* farther in the taper hole in casting, thereby tightening the adjustment. *D* is the adjusting nut for end play of the spindle and *E* is the lock screw. *F* is a bronze bushing driven into the pulley, *G* a hardened collar, *H* a brass dust cap, *I* the hardened and ground spindle and *J* the lock screw for spindle.

*Foreman of grinding department, Scovill Manufacturing Company, Waterbury, Conn.

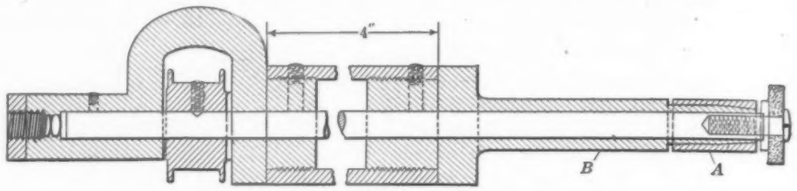


Fig. 3

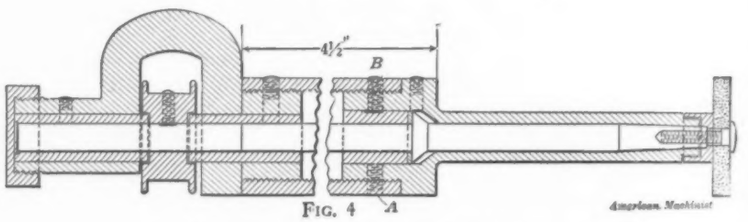


Fig. 4

Improving the Internal Grinder

Internal Grinding Spindle

Fig. 3 is an internal grinding spindle which when used constantly, 10 hours per day, for one month at a speed of 20,000 revolutions becomes useless if it is desired to obtain satisfactory work. The adjustment for side shake is accomplished by tightening cap *A* on bronze box *B*, which is tapered on the end, and split in 3 places. This design is very unsatisfactory as it only allows adjustment at extreme end of bearing, and the adjusting cap is continually coming loose on account of the vibration. The end play is adjusted at the rear end of spindle as shown in Fig. 3.

No provision is made to exclude the dust from either bearing.

Fig. 4 is an improvement on this spindle, using most of the same material.

Screws *A* and *B* are for adjusting the side and end play, by adjusting spindle toward the end of the box.

The rear boxes were rebored and bronze bushed to assist in repairing which can be easily done by inserting new bushings. These were made to extend inside the pulley to exclude the dust.

This design will not allow heavy grinding on the back face of wheel, as this will push spindle in taper box causing undue heat. It would not be desirable to reverse the taper as the front face of wheel is used extensively for facing the shoulders on work having two internal diameters.

The machine using these spindles is exceptionaly well designed. We are at at present using two of these specially arranged for internal grinding, and find them much more satisfactory than the longer type of internal grinders. They are easier to operate and produce fine work very quickly and the cost of this machine is about one-third that of the longer machines.

Flow of Heat through Furnace Walls

A bulletin published by the Bureau of Mines, Department of the Interior, under the title of the "Flow of Heat through Furnace Walls," prepared by W. T. Ray and Henry Kreisinger, takes up the subject in a concise and comprehensive manner. The conclusions of the paper are summarized as follows: In furnace construction a solid wall is a better heat insulator than a wall of the same thickness containing an air space. This statement is particularly true if the air space is close to the furnace side of the wall, and if the furnace is operated at high temperatures. If it is desirable in furnace construction to build the walls in two parts, so as to prevent cracks being formed by the expansion of the brickwork on the furnace side of the walls, it is preferable to fill the space between the two walls with some "solid" (not firm, but loose) insulating material. Any such easily obtainable materials as ash, crushed brick, or sand offer higher resistance to heat flow through the walls than an air space. Furthermore, any such loose material by its plasticity reduces air leakage, which is an important feature deserving consideration.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room. A letter good enough to print will be paid for. The value is in the idea—not the length of the letter

Special Machines Used in Building the Moon Motor Car

Among other interesting machines and fixtures used in the shops of the Moon Motor Car Company, of St. Louis, Mo., are the two shown in the halftones, Figs. 1 and 2, which are the design of S. B. Igow, superintendent.

The machine shown in Fig. 1 is a Garvin No. 3 duplex miller of special design for the piece of work shown. In this machine both the tops and bottoms of the cylinders are machined at one setting in the time required to mill *one* surface. The fixture carries four cylinders, which are cast in pairs.

Boring Crank Cases

Fig. 2 shows a William Parker lathe converted into a crank-case boring machine of rather unusual construction, and is a good example of what may be accomplished by home production. Before building this fixture, some of the special-tool builders were consulted, and it was found that a suitable machine would cost between $1200 and $1500, while the cost of the rig shown was less than $500, and it does the work both rapidly and well.

The features of the greatest moment are the *fixed* center distances, rigid support, and unusual size of the boring bars. The support *A* is held by a bolt and shoe in the same manner as the tailstock of a lathe, which allows it to be readily removed in order to slip the cases on and off the fixture. The work is located by two hardened-steel pieces that fit the bored holes in the upper side of the case, which is drawn down to the platen on the lathe carriage by suitable bolts. Two sets of high-speed cutters are used, one for roughing and one for finishing, and the driving gears *B*, while in use, are protected by a housing, which is removed for photographing.

Poplar Bluff, Mo. M. E. Hoag.

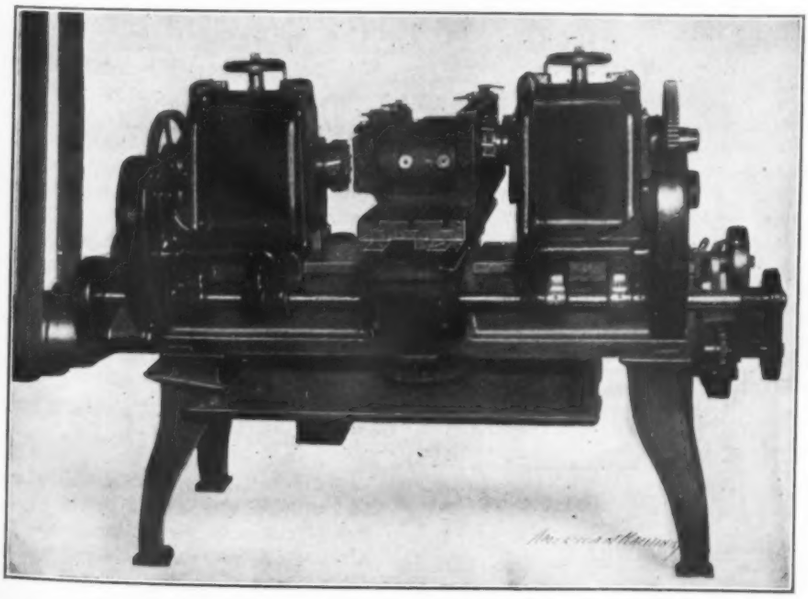


Fig. 1. Special Garvin Machine Designed for Milling Cylinder Castings

An Adjustable Cutter Head for Tube Sheets

In the accompanying illustration, Fig. 1 shows one kind of tube-sheet cutter that is sometimes used in boiler and similar work. The body is slotted to receive inserted blades of suitable size and *A* is a band shrunk on to hold the cutters or blades in place by means of set screws.

By using a body such as shown in Fig. 2, more than one size can be bored with the same head, by milling the body to allow of tool-steel pieces *B* to be inserted of various thickness within the capacity of the head; *C C* represents two lugs inserted in body which fit into a slot cut across the end of the drill spindle and prevents the twisting off of the tang and *D* is a screw used to keep the inserted pieces in place when changing cutters.

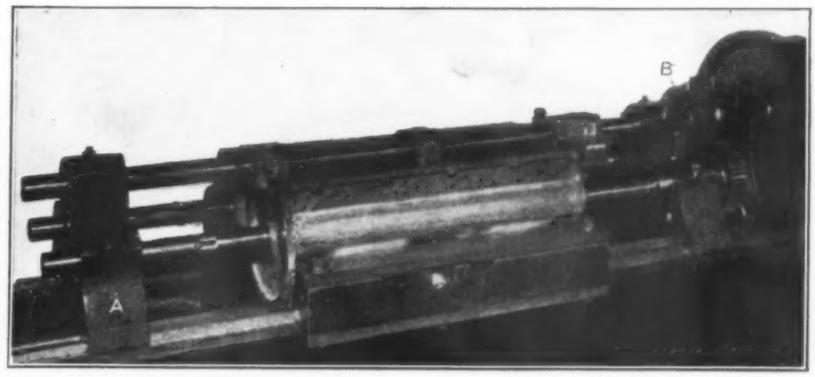
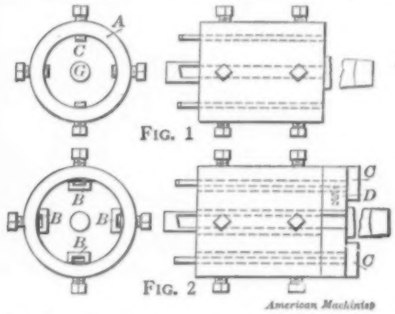


Fig. 2. Lathe Converted into a Crank-case Boring Machine



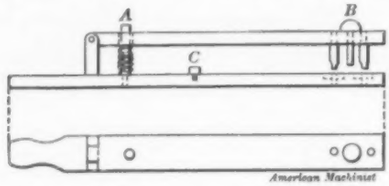
An Adjustable Cutter Head for Tube Sheets

Ottawa, Canada. J. D. Y.

Punching Two Rows of Holes in Thin Metal

A very handy device for punching two holes at once in thin metal is shown herewith.

The base of the device into which the dies are set consists of a long piece of machinery steel with one end shaped into a handle. Mounted on it by a hinge, as shown, is another bar which carries the punches. About two inches from the hinge is placed a ½-in. pin *A*, which serves as a guide to line up the punches



PUNCHING TWO ROWS OF HOLES IN THIN METAL

and dies, and which also carries a spring stiff enough to open the punch when struck and keep it open the required amount while inserting the sheet.

A pin *B*, having a large round head set half way between the punches, serves the double purpose of receiving the blow of the hammer, and also acting as a stop. Another stop *C* is placed the required distance from the punches, so that the holes may be gaged the correct distance from the edge of the sheet.

By the use of this fixture a double row of rivet holes at any given distance from the edge of the sheet can be laid out with astonishing rapidity.

Cleveland, Ohio. G. M.

Swivel Joint for Air Pipe

Accompanying is a sketch of a revolving joint for an 80-pound air-pressure pipe, which I designed for manipulating one or more air hoists on a continuous circular track.

As I have looked through quite a number of catalogs relating to this subject and am unable to locate anything in the market to suit this or similar conditions, I thought that it would prove interesting and attractive to the readers of the AMERICAN MACHINIST. This particular joint has been used for two hoists, while we have made others for four.

Chicago, Ill. J. H. SAWYER.

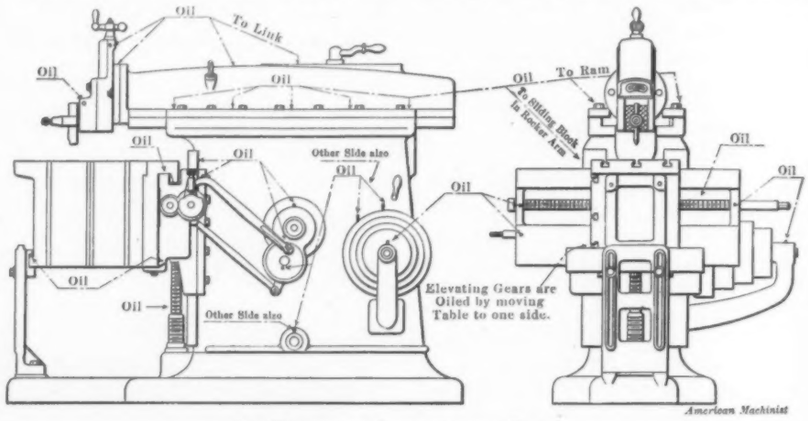
Proper Oiling of Machinery

More attention should be given to oiling bearings. Many a tool has been returned to the manufacturer as defective, when the only trouble was a lack of good oil.

Our boss floorman has strict orders to test all oil holes with kerosene to see that there is a free flow of oil to the bearings, and this is done along with other tests for accuracy, etc., while shapers are being run off.

We submit herewith sheet showing oiling diagram and instructions. We paste one of these inside the door of every shaper we ship. We were forced to do this, because we found that in many cases the shaper is placed in the hands of boys or unskilled workmen, and not properly looked after by the man in charge. We have also incorporated in this sheet instructions for operating our feed, which is different from any other, and which we found was often misunderstood, and not used so as to get best results, either as to rapidity of changes or durability of the mechanism.

A. M. WATCHER.
Secretary and Treasurer,
Queen City Machine Tool Company.
Cincinnati, O.



AN EFFICIENT LUBRICATING SYSTEM

CLEAN MACHINE WELL. OIL ALL MOVING PARTS DAILY. SEE DIAGRAM BELOW. Extra precaution should be taken to fill cup in TOP OF SLIDING BLOCK, this being done through SLOT IN ROCKER ARM, and for which door must be removed.

FILL CHANNEL IN TOP OF LINK: this is done by dropping plenty of oil through slot in top of ram, several inches in front of tightener handle; it should drop on the screw which can be seen through this slot, and from there it will drop to channel in top of link.

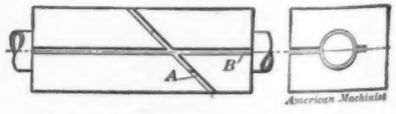
REMEMBER, this Shaper is FULLY ADJUSTED AND READY FOR WORK: it only needs to be cleaned and well oiled, and only a COMPETENT MAN should adjust it if worn after long use.

THE FEED: all feed changes are made by CAM at end of CROSS TRAVERSE SCREW. When feeding BE SURE to have BEVEL SIDE OF PAWL PIN towards lift on CAM; BE SURE that feed takes place on RETURN MOVEMENT of RAM, this being governed by means of LEVER on feed rod, which lifts plunger out of eccentric, when it will move automatically to opposite side. DO NOT HOLD LEVER just lift—and release it. This MUST be done whenever direction of feed is changed.

Queen City Machine Tool Co., Cincinnati, O., U. S. A.

Sawing Tubing at an Angle

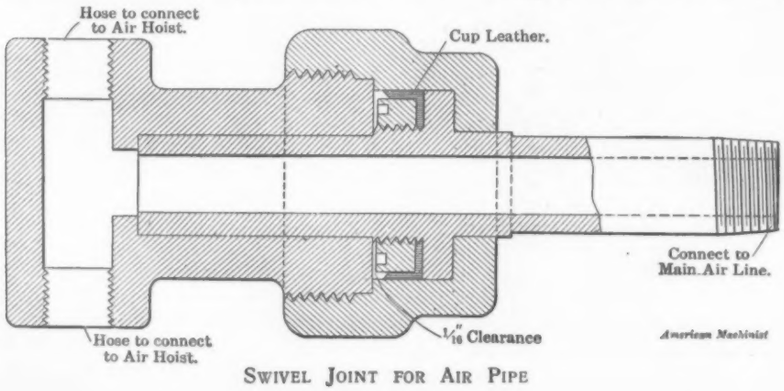
We had some 15/16-inch brass tubes to cut, and the length had to be 14⅝ inches, while one end had to be beveled to a 45-degree angle. The tubes were so thin that in clamping them in the machine they would mash, so a jig was made as shown in the sketch. This jig was made of cast iron, and a hole was drilled through the center of the block, then a slot was cut on a 45-degree angle,



SAWING TUBING AT AN ANGLE

as shown at *A*, and another one cut parallel with the hole, as at *B*. The jig was then placed in the vise of the saw so that when the vise was tightened the jig would clamp the tubing securely.

Washington, D. C. H. D. CHAPMAN.



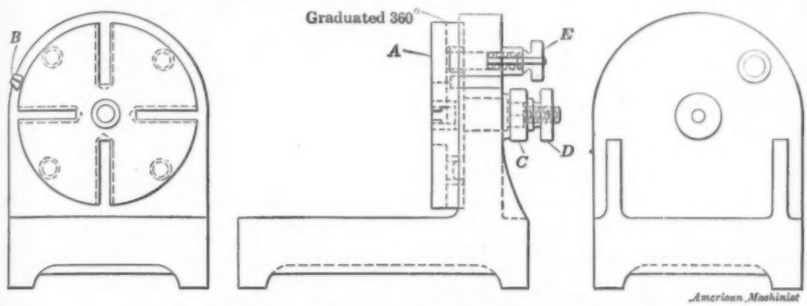
SWIVEL JOINT FOR AIR PIPE

Angle Plate for Laying Out Sheet Metal Work

The sketch shows an angle fixture which, with the use of the hight gage, is for laying out of model and experimental sheet-metal work, such as required in adding-machine construction. Some of this work has many angles to lay out, so that the advantage of this fixture can be readily seen.

Plate *A* is graduated into 360 degrees, beginning at the indicator *B*, which is dovetailed with the upright of the angle plate. The nurled nut *C* has a square hole in it and is a sliding fit on the shaft of plate *A*, which is locked in any position by the nurled nut *D*, and pin *E* is for locking the plate when using the fixture on 90-degree work and needs no explanation.

Detroit, Mich. DAVID MELVILLE.

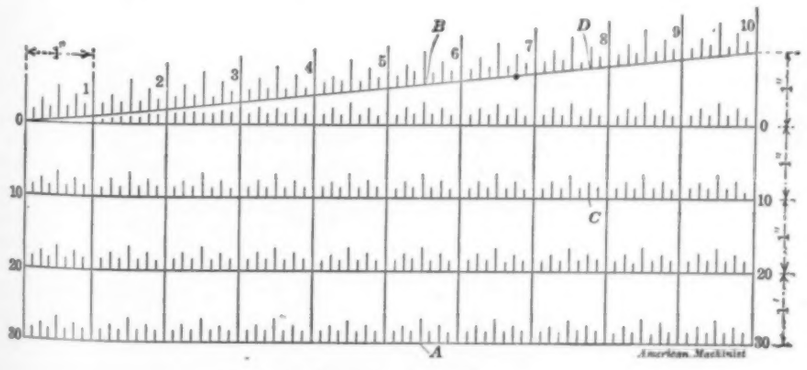


ANGLE PLATE FOR LAYING OUT SHEET-METAL WORK

An Improvised $\frac{1}{10}$ Scale

I had occasion to make a number of sketches to a reduced scale (1 to 10). No suitable scale was at hand, so a drawing similar to the inclosed sketch was made full size and mounted on a piece of cardboard. This enabled me to get all dimensions very easily.

I think the manner of using this scale is self-evident. By reading along the upper diagonal line on the scale and stepping off the corresponding distance in a vertical direction, any dimension up to 40 inches could be obtained, which was all that was required in my case.



AN IMPROVISED 1/10 SCALE

A Single Purpose Boring Machine

The use of single-purpose machines is becoming more and more general where quantities of accurate work must be turned out. Many of these machines are to all intents and purposes elaborated jigs and such is the one shown in Fig. 1, which was built by the Trenton Engine Company, Trenton, N. J., for boring the cam-shaft bearing holes and crank bearings of their engine crank cases. The parts bored on this machine are indicated by the arrows at *A*, the holes for the cam-shaft bearings being the same in either end, though the crank bearings vary in number according to the number of cylinders, but the actual travel of the cutter bars in any case is not great so hand feed is employed. It will be noted from the halftone that the body of the machine is made of structural iron and that the three main brackets or bearings are all cast from the same pattern, bringing out the economy of the construction.

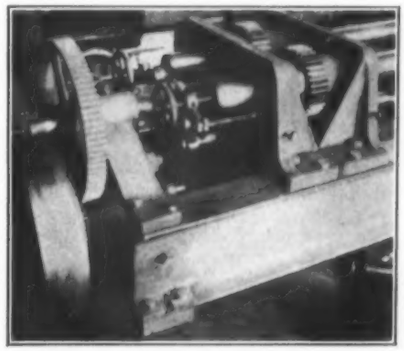


FIG. 2. VIEW OF WORKING PARTS OF BORING MACHINE

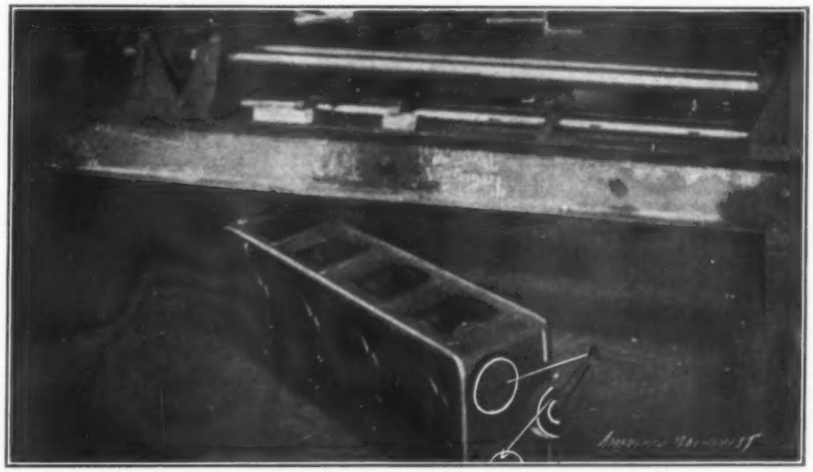


FIG. 1. SINGLE-PURPOSE MACHINE FOR BORING OUT BEARING HOLES IN CRANK CASES

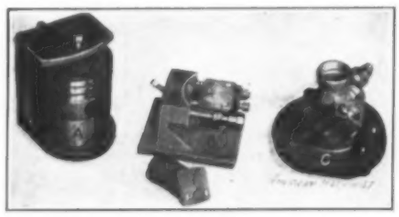


FIG. 3. GROUP OF LATHE FACE-PLATE JIGS

In putting the crank case on the machine, the end bracket is removed and the case slipped on lengthwise of the bed, lined up and clamped in position.

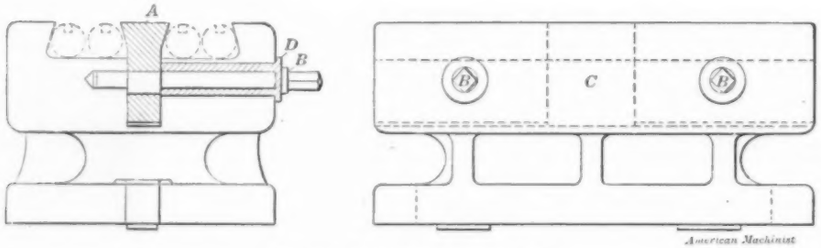
Fig. 2 shows an enlarged view of the business end of the machine, the driving pulley being back-geared to a shaft which drives the boring bars and the small handwheels shown are used for feeding.

Fig. 3 shows three face-plate jigs used in this shop, *A* being a jig placed on a lathe faceplate while boring out the wrist pin hole in pistons; *B* is used to hold air-pump cylinders while surfacing the bracket flange as shown, while *C* is used to hold water-pump castings for boring and threading the large hole. E. V.

Small Shaft Splining Jig

The accompanying sketch shows a milling-machine jig, used for holding small shafts while splining. These shafts are of selected gun-rod stock and are placed in the jig, four at a time, and splined for their entire length, using a gang of milling cutters.

The four shafts to be operated on are clamped in the fixture shown by means



SMALL SHAFT-SPLINING JIG

of two hardened clamps like *A*, in which there are elongated holes which admit of their being drawn downward by rotating the eccentric shafts *B B*. The space between the two clamps is filled in with a fitted machine-steel piece *C*, and on account of the eccentric shafts, slip bronze bushings like *D* are used in order to assemble, and which are prevented from turning by small gib screws.

While the jig should be built up of machine steel carbonized, hardened and ground, I have shown it as a steel casting.

Detroit, Mich. DAVID MELVILLE.

Looking for a Job

Did you ever try "looking for a job" or are you thinking that you will do so some time in the future?

There are many ways of doing this, ranging from opening the door, sticking in your head and yelling, "Say, mister, want any boys?" to "I might accept a position if you have one to offer." Neither of these ways are good ones, and both will get more rebuffs than jobs. I have hunted for a job several times in my younger days and now for several years have had boys come to me for jobs, so know how it is to be on both sides of the question.

In looking for a job, most boys simply take up the first thing that offers, and if they can keep it, drift along for a time until something else offers a little more money, when they change, regardless as to the future. This results in a boy suddenly finding himself a man with no trade or future, and when he wants to marry and settle down, all he has to look forward to is the wages of an unskilled man; so the first thing to do is to make up your mind what you want to do through life. I know it looks a good ways ahead to you now, but manhood and age come so quickly, you will wonder where the time has gone to, so give this a lot of careful thought, and talk with your people about it. You will be surprised to find how anxious they are to help you.

When you have settled on your future, then carefully look over the available openings near home; don't think because a job is 500 miles away, it is much better than one with your next-door neighbor. You know all about the bad points of your neighbor's place, but do you know all about those in the distant position and do you know how easy it is to get into bad company and bad habits when you are away from your home's restraining influence? Well, I do, and I also know that bad habits are the hardest things in the world to keep out of the sight of the boss, and they have lost many a good man and boy his job while someone not so capable, but who could be depended on, has held the job all right. Then the fellow who got fired talked about "hard luck" and "suckers" to others of his kind. Well, that's enough for the lecture part, now we will look for "the job." If there are several places that have the kind of work that you are looking for, pick out the best one first, and make it a point to find out who does the hiring in your particular line. If you can get an introduction and a good word to him through some *good reliable* party it helps immensely, but don't make the mistake of being introduced by a poor shiftless kind of a man who either is just holding his job, or else can't hold one.

If you cannot get an introduction or perhaps cannot find out whom you need to see, your best way is to go directly to the office and inquire. Do not write your application unless you are a good penman and can write a good letter, or unless the employer asks for it that way; for a poorly written, misspelled application is bad. You should be as neatly dressed as your circumstances will permit, not overdressed, but in a sensible way, and don't think because your clothes are poor, that it cuts down your chances, for men look beyond the outward clothes and if they are neat and clean the chances are that the boy is too. Then, too, a bright and manly face tells a great deal.

Don't misrepresent, don't claim to know it all; the employers have seen too many of this kind and a question or two that you may think don't amount to anything frequently tell all they need and you are turned away wondering why.

Give plain, straight answers to all the questions, answer them as you would want one to answer you and don't be afraid. The man who is talking to you may be quick and rough in his talk, but remember he has a lot to do and no time to visit. You are an unknown quantity to him and he has to meet so many of the same kind that you are only one unit in his experience, and it is up to you to prove to him that *you* are more than a unit and that you will be a help. Right here let me say, don't ever even think that you are doing all that you get paid for, and that you won't do any more until you get more money; for if you don't do more than you are paid for how is your employer going to get money enough to give you that raise that you want? It is the man who makes the most money for him that he pays the most money to and the one that he cannot afford to get along without. Remember that and you will hold your job.

If you write your application, just think what you would want to know if you were hiring a chap about your size and tell it plainly and simply. If you cannot write a good letter get some friend to help you but have it in your handwriting.

To sum it all up, be neat, be respectful, be honest; look your man in the face, answer all questions in a few words and to the point. Don't run down previous employers or others, and finally when you get your job be square with your employer and you will keep your job when others walk.

Syracuse, N. Y. E. Q. WILLIAMS.

It's a good plan to assume that the builder of a machine knows a little about it and that it will pay to follow his instructions, at least till you have found a better way. If any directions seem complicated, its a safe bet that there is a reason for it. No sane builder wants to make it any harder than necessary to learn how to operate his machine.

Discussion of Previous Question

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers

Hardening Tool Steel

On page 265, Volume 34, is an article under the above title which might be read by a number of young men who have not had a great amount of experience in tool hardening and to whom the article would be misleading. In his article Mr. Leckie advises that the tool steel be sprinkled with table salt and then heated until the salt fuses, at which heat the tool should be quenched. This is to say Mr. Leckie quenches all his tools at 800 degrees Centigrade, the fusing point of sodium chloride, but surely Mr. Leckie knows that the best result is obtained by quenching tool steel at a temperature a little above its recalescence point—the period of the hardening state at which the maximum strength is obtained; and also that the term "tool steel" is a very broad one, and may include a great variety of carbon steels in which the critical points may occur, roughly, anywhere between 700 and 800 degrees Centigrade, dependent chiefly on the percentage of carbon.

Now, if we have a steel which will harden at, say, 725 degrees Centigrade, it will certainly be wrong to quench it at 800 degrees, for if not actually "burnt" it will be overheated to such an extent as to render it far too brittle to use, and subsequent drawing will not entirely give back the strength.

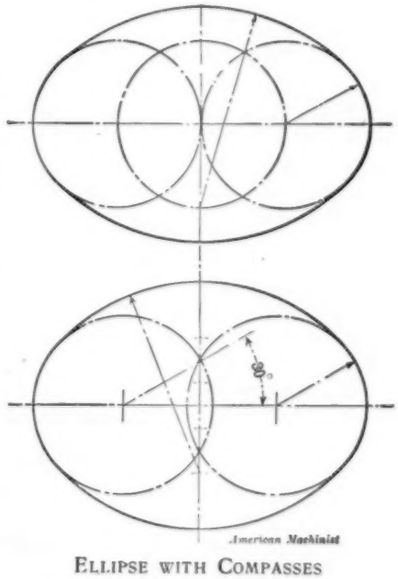
It is not desirable to use exclusively one brand of steel for a variety of uses, even if one were obtained that had its most efficient hardening temperature at 800 degrees Centigrade. Tool steels are now made in a great variety, each having its special properties, and so I would suggest that several steels of known qualities be kept in stock. Taking each steel separately, find the lowest temperature at which it will harden and then buy a mixture of salts that will fuse at this temperature and we will have a fairly reliable pyrometer for use with it, and when a tool has to be made, the steel will be chosen that has the particular properties required and our salt pyrometer will prevent the overheating which is so disastrous to the strength and structure.

Mr. Leckie tells his readers that they may gamble their month's pay the work won't be cracked if his instructions are followed. I don't think he would gamble his. I wouldn't mine, for I fail to see why he thinks salt will prevent cracking. To me it seems that cracking is dependent more upon the rate of cooling and is generally caused by the unequal cooling, owing to shape and bulk of metal. It seems as if the effect of salt upon the quenching water is merely to make it a better heat conductor and thereby hastens cooling, and everyone knows that to hasten cooling, though it helps the hardening, does not at all eliminate the possibility of cracking, but rather the reverse—otherwise we should see less of delicate work being quenched in oil and extreme hardness sacrificed.

Tettenhall, England. A. E. L.

Ellipses with Compasses

There have been lately contributed to the pages of the AMERICAN MACHINIST several methods relating to the construction of ellipses; all of them may be good and useful, but none gives a constructive simplicity and readiness, resulting in a true, standard elliptic shape.



ELLIPSE WITH COMPASSES

To this fact I must add that the mechanic who wants to make an ellipse, should make it as easily as he does a circle with his dividers and not have to look for methods and tricks at the very moment he wants to lay it out. That, of course, takes time and the ellipse so constructed will never have a regular shape, always leaving the mechanic in doubt as to which method is the better to follow.

My opinion is that the ellipse construction, which has so many methods, and which can be made as well with no method at all, must be standardized to give always a true shape to all sizes.

I here show two sketches of methods known to me. Both are very simple and give good shapes; they can be applied on paper or on the machine part directly, as they require no other tool except the dividers, and are free from calculating. The major axis is taken as a base and the length of the minor axis is determined by the method itself, always to a constant proportion in all sizes.

PAUL A. BONIS.

Phalerum, Greece.

How Would You Perforate These Sheets?

I have a large number of leaded-steel sheets or strips to perforate.

These are 3¼ inches wide, 6 feet long, 0.065 inch thick, the holes being ⅛ inch diameter and 7/32 inch pitch and extending practically the full length of the sheet. We are at present punching them in an ordinary press, using an automatic feed and trip and gang punches.

We have tried many ways of arranging the punches both in numbers and pitch, putting the sheets through as many as four times to complete the full perforation, but find continual trouble with broken punches.

This is, no doubt, principally due to the thickness of material and small hole required, but we cannot make any change in this direction.

Could any reader suggest a way out of the difficulty? We handle some thousands in a year and the expense of a good method or machine would be a small item.

Some imp within my brain suggests a rotary method. Is this possible?

Belfast, Ireland. ROY.

Locating Holes Accurately in the Milling Machine

Referring to the communication of Geo. E. Gay, on page 76, he seems to be stuck on the button and plug system, and shows a way requiring ten plugs to operate. As the riot caused by the indicator shown by Mr. Murdock in his article published on page 337, Volume 33, Part 2, seems to be on the increase we may expect to see many more impracticable schemes to do work that does not require any such complications. To my mind making all these plugs, as well as

the other work on the buttons, etc., is a waste of time that any shop in this country having wideawake management would not tolerate. On page 77 I find an article by Mr. Metcalf on the inefficiency of the center punch as a precision tool. He calls it a crude tool. Perhaps in unskilled hands it is, but if so, must we then abandon many other necessary tools that have stood the test of time? The artist's brush may do bad work in the hands of a bungler, and so may the center punch. Many a man has a fine kit of tools, micrometers, verniers and others, but that does not make a good mechanic of him. Lines drawn by the vernier hight gage at right angles, or at any other angle can be worked to by a skilled mechanic and accurate results produced. Most punch and die work must be made from lines drawn on the metal, and the results obtained are a sufficient refutation of the statements made by Mr. Metcalf.

As to the Murdock indicator, to my mind it is the best and most time-saving device I have seen in a long time; no need to spend eight or ten days on work when equally accurate results can be obtained inside of two days. I speak from experience, for I have both used the tool, and have had others use it, and yet have to see any job where the results obtained were not as good as could be had with buttons, and better for there is not the chance for accidental moving of the buttons or making mistakes in micrometer readings.

What is to be done with the button system when eight or ten small holes are in a bunch close together? The button method falls flat on such a job, but it can be done with the Murdock indicator and done right, by a skilled man who knows how to lay out, and otherwise correctly prepare the work up to the time when the indicator is used. I have seen lots of trouble with buttons and other methods, but none with this.

CHARLES F. HARPER.

West Orange, N. J.

Broaching Instead of Planing Keyways

I was interested in an article on page 606, showing how a 5/8-inch keyway in 1½-inch hole 13½ inches long had been done on a planer.

I agree that this was a very ingenious idea in conceiving the method of cutting what may be considered a rather difficult keyway, owing to being in such a small hole and of the length mentioned.

Although the production was not very rapid, being as stated only 2½ per hour, the mechanic who conceived the idea of doing this work in such a practical way should be given credit, but at the same time I wonder if people who read the article realize that the very same work can now be accomplished on a good broaching machine at a rate of 20 to 25 per hour.

For example, a 5/8-inch keyway 10 inches long, is cut in two minutes. Now, while this was in a larger hole and 3½ inches shorter, the metal for the keyway must be removed the whole length of the hole, while the work shown in the article was chambered in the center, leaving not over two inches of keyway to be cut on each end.

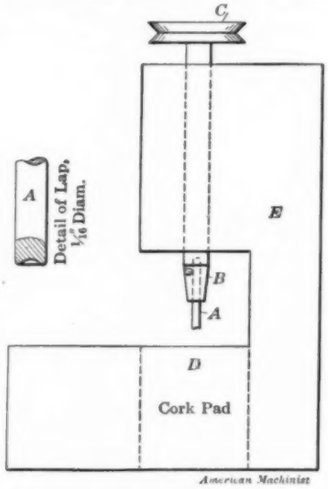
I might add that a ½-inch, 5/8-inch, or almost any size keyway can be cut in a hole as small as 1½ inches or smaller, 13 inches or 14 inches long, with practically the same facility as cutting in a larger hole. We have had cases where ½-inch dovetail keyways have been cut in one operation in holes 14 inches long.

J. N. LAPOINTE.
President Lapointe Machine Tool Company.

Hudson, Mass.

Drilling Glass

I have read with extra interest on page 1170, Volume 33, Part 2, the way in which "Norwood," drilled those reflecting mirrors for special testing machines, as I have had a very similar job to do in connection with microscope arrangements,



FIXTURE FOR DRILLING GLASS

for special measuring machines. It was necessary to see the exact spot of the article, being measured, and this was obtained by mirrors which had to be as thin as possible, in order to get a clear image. The mirrors used were 0.010 inch thick, shape oval, about 7/8 inch long by 5/8 inch broad with a 1/16-inch hole through center. One thing we found out about these mirrors, was, that they could not be drilled on any of the sensitive drill presses, in the shop, as they were far too clumsy for such a delicate job and I would very much like to know how Norwood drilled his mirrors. We did not get a chance of minute cracks but broken glasses every time we tried to drill them, until we made a device as per inclosed sketch, which made a beautiful job, and from what I can see of it now, is, I think much quicker than Norwood's method.

The body of the device is made of gray iron, and for our purpose was about 1½ inches thick. *B* is the spindle hardened, ground and drilled to take *A* the lap which is held in by grub screw. *C* is the pulley and *D* a cork pad 7/8 inch diameter to seat the glass upon. The spindle *B* was a free fit, without shake, running in a reamed hole. The lap is hollowed out at bottom and rounded off, so that it breaks through the glass about 0.020 inch smaller than finished size and then gradually grinds its way through to the full diameter leaving a clear cut hole free from any flaws whatever. The lap was charged with fine diamond dust and used with fine machine oil, also the cork pad was smeared with oil, before laying the glass upon, thereby helping to hold the glass flat, keep it cool and acting as a lubricant when the lap is breaking through. After drilling a glass the cork is pushed up and shaved off flat ready for the next glass avoiding any hole which the lap is liable to make because the glass must be fully supported around the hole, until the full diameter is reached.

The device was gripped in the vise and run from small motor at from 5000 to 7000 revolutions per minute using a piece of thread for belt and no pressure, except the weight of the spindle and pulley, this being quite sufficient. I have used the drill, the description of which Norwood gives, on many occasions, and know that it is a very good one, but I should not care to use it, for reaming the last 0.002 inch out of a hole, as Norwood suggests, why not grind out to size with his diamond lap, surely this is more convenient and quicker. The drill unless carefully made, and ground after hardening, will frequently be found cutting on two of the corners only, hence the danger of getting flaws in the glass.

Leister, England. X

Fountain Pen for India Ink

Supplementing B. E. Winslow's remarks on the above subject, on page 361, I wish to add, that until about two years ago, I longed in vain for a fountain pen which would satisfactorily handle india ink.

In a store one day, my attention was attracted to a new type of fountain pen of peculiar, but simple construction. When closed it is sealed like a bottle, and the pen is submerged in the ink which, of course, washes and lubricates the feed and particularly the split or business end of the pen.

I was immediately impressed with its adaptability for the thick and volatile india ink, and purchased one, selecting a stiff, smooth nib with a fine point. It has been in satisfactory use ever since.

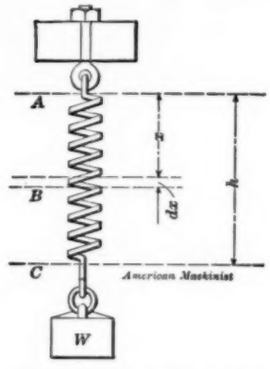
There are several standard makes of these "safety" pens, I find, and when closed they may be carried like a pocket knife.

The immediate, distinctive and permanent black of the india ink is of special utility in the making of records, reports, charts, etc., and a practical fountain pen greatly facilitates its use. The combination is especially valuable in modern drafting-room methods.

Boston, Mass. WM. E. CHOATE.

Effect of Inertia of Helical Spring

In many machines where springs are used to produce rapid motion of the parts to which they are connected, it frequently happens that the weight of the spring itself has to be allowed for if a good result is desired. This has nothing to do with the point discussed on pages 268 and 147; that was for static work, while this case deals with the inertia effect such as for a rapidly opening and



INERTIA OF A HELICAL SPRING

closing valve. The problem of determining the effect of the weight of the spring upon the motion produced is easily solved when approached from the kinetic energy point of view.

Consider the case of the helical spring shown in the sketch, supported vertically and carrying a known load at its lower extremity. The spring and load are supposed to be in a position of equilibrium. If the spring be compressed or extended and then let go, it will begin to oscillate vertically and the point C will approximately be the mid point of the free path of oscillation.

Let W be the load in pounds; W_1, the total weight of the spring in pounds; a, the weight of the spring in pounds per foot of length; v, the velocity of the load at any instant in feet per second; v_1, the velocity of any part B in feet per second. Since the spring is stretched uniformly throughout its length, which involves the condition of uniform elasticity, the velocity of any point, such as B, distant x feet from A, will be proportioned to the distance from A to B. Hence, the velocity of B is

$$\frac{x}{AC} \times v = \frac{xv}{h}. \qquad (1)$$

Consider the kinetic energy of a small portion of length dx of the spring. Its kinetic energy is $=$

$$\frac{a\,dx\,v_1^2}{2g} = \frac{a\,dx}{2g} \cdot \frac{x^2 v^2}{h^2},$$

from (1). The total kinetic energy of the entire spring and the load is

$$= \frac{Wv^2}{2g} + \frac{av^2}{2gh^2}\int_0^h x^2\,dx$$

$$= \frac{Wv^2}{2g} + \frac{av^2}{2gh^2}\left[\frac{x^3}{3}\right]_0^h,$$

$$= \frac{Wv^2}{2g} + \frac{av^2}{2gh^2}\cdot\frac{h^3}{3},$$

$$= \frac{Wv^2}{2g} + \frac{W_1}{3}\cdot\frac{v^2}{2g},$$

$$= \left(W + \frac{W_1}{3}\right)\frac{v^2}{2g}.$$

Hence, we see that one-third of the weight of the spring has to be taken into account. The above result is quite general and is of great service in designing automobile valve springs and springs for indicators where rapid vibration is required and inertia plays an important part.

Detroit, Mich. J. M. THOMAS.

Design of Ball Thrust Bearings

Mr. Hess, in his article on page 33, states that my reasoning is based on the wrong assumptions "that the load is constant" and "that the friction at the plate is constant." It is not easy to see why it should be wrong to assume the load constant, but Mr. Hess' statement is erroneous anyhow, for the fact remains that the formula in question is derived without any assumption at all, and therefore the conclusions hold good for *any* load and for *any* value of the friction coefficient.

As to the new point raised by Mr. Hess—that the vibration of the machine will help the bearing—it would be interesting to know just what Mr. Hess means with his expression "vibratory relief of the load" for instance in the case of a screw hoist where the vibration of the screw is generally considered negligible. It is clear enough that the vibration of the machinery, where it cannot be prevented, will reduce the value of the friction coefficient, but that does not affect the question, unless Mr. Hess actually assumes that the friction is reduced to nothing. If there is still some friction left at the plate, the formula is valid for the values of R, L and f which may obtain. It is easy for anybody to compute from the formula what difference in load there may be on opposite sides of the bearing, for any supposed value of the friction coefficient, and to satisfy himself that the spherical seat does not by far perform its function in such degree as sometimes claimed.

That the question of a proper ratio between R and L is frequently not considered is evidenced by the fact that instead of making R as small as practicable it is generally made needlessly great, sometimes as great as 10 times the distance of a ball from the center line of the shaft.

As to the diagrams in Mr. Hess' article, I wish to point out that he has not correctly reproduced my Fig. 2, neither in itself nor in its relation to Fig. 1 of my previous article. His Fig. 3 may be set aside as of no practical value. But his Fig. 4 is very interesting, especially if it is completed as here shown in Fig. 1 with the necessary lateral bearing B, and arranged obliquely to indicate a condition of initial inaccuracy. Mr. Hess contends that he effects an improvement in the bearing by making the seat A loose so that it may slide "transversely," and he asks us to believe that this feature provides an arrangement "to allow for universal relative adjustment for any condition of initial inaccuracy or of subsequent deflection." Mr. Hess also states that

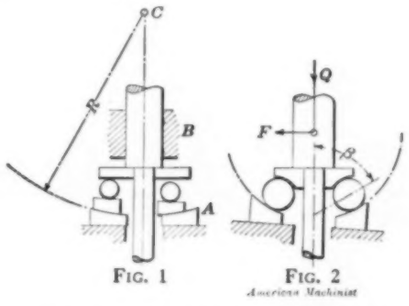


FIG. 1 FIG. 2

DIAGRAM OF THRUST-BALL BEARINGS

"this arrangement allows the correct motion for relative alinement whether the balls roll on flat tracks or in grooved tracks on one or both races."

It is not clear why the plate A, once installed inaccurately, should ever slide at all transversely in the direction desired by Mr. Hess but anyhow, if it actually did slide, it would not help matters because then the center C would move out from the center line of the shaft. So it appears that the addition of the loose plate A is a complication but no improvement. The explanation advanced by Mr. Hess that the fact is not affected "whether the theoretical reason to account for a condition be right or wrong" does not look satisfactory so far as it relates to Fig. 1.

The arrangement for a thrust bearing, shown in Fig. 2, seems to offer a better solution of the problem. In this diagram the front, and not the back, of the stationary race is spherical, and such a bearing offers the following advantages:

It acts not only as a thrust bearing, but also as a lateral bearing against any side pressure not greater than $\frac{Q}{tan.\,\beta}$. The bearing is simple and requires no sliding

of the race. It is automatically self-alining, the balls must always roll *in true circles* on the spherical race, and the thrust is equally distributed on the balls.

If used with only three balls, the maximum pressure on any one ball can be easily computed.

The importance of proper alinement between the races in any ball bearing, whether for end thrust or for lateral pressure, is well recognized by their makers, who generally urge the exercise of extreme care in fitting them. It is often difficult to secure and maintain the accurate alinement, and it appears that those types of ball bearings which are automatically self-alining have an advantage over other types.

GUSTAF RENNERFELT.

Karlstadt, Sweden.

Linings Used for Machine Bearings

Seeing the interesting article on cast iron for machine bearings by R. K. Le Blond on page 537, brings to mind a personal experience along these lines.

My case does not deal with cast iron, nor with a machine tool, but with bronze and babbitt used in the main bearings of three electrically-driven air compressors. These machines developed several hundred horsepower each and the customer, being obstinate and certain that his own opinion was better than that of the well known builders of these machines, one of whose first aims was to uphold their own high reputation for producing a reliable product, insisted upon having phosphor-bronze quarter boxes for the main bearings.

These units, as ordinarily built, would have been supplied with cast-steel boxes lined with first-quality babbitt, well hammered into dovetailed grooves, bored and scraped to the true bearing surface. The main shafts were of forged, open-hearth steel, carefully heat-treated, turned and ground, though not hardened. This construction was known to give the best results for this duty and the customer not only was informed to this effect, but was told that the bronze boxes would entail a very considerable extra cost per unit.

As is often the case, experience of the builder counted for naught, and the three machines were shipped with the precious bronze boxes. There was no surprise when a complaint soon came from the customer to the effect that the bearings ran hot from the start and continued to stay hot. Nothing in the line of special lubricants would help any; the hose was the only salvation.

Pressures per square inch of bearing surface again were figured and found to be especially low; but even this information did not serve to keep the customer cool, to say nothing of the boxes. He insisted that something be done, so an erecting man was sent off to take the machines down and reërect them in absolute alinement, on pain of losing his job. This was done and the boxes rebored and scraped; still they were as hot as ever.

This condition continued for a year or more, during which time the machines were once more torn down and reërected even more carefully. Finally, the customer was so very unhappy that he meekly asked for advice, which was cheerfully given, as it freely had been all along: to replace those bronze boxes with babbitted ones. As the customer had begun to realize that his own ideas were not always satisfactory in their results, he surrendered and the boxes were duly changed. From that time on there has been no complaint about those bearings, so the babbitt proved to be the correct thing to use in this case.

New York City. R. S. BAYARD.

Moving the Tailstock Easily

On page 217, W. R. Oakes, of Manchester, England, shows how they rigged up to make it easier to move a heavy tailstock on their lathe. We had the same problem some twenty years ago, and solved it somewhat differently, and we think, better, due perhaps to the fact that the nature of the American construction was more favorable than the usual English type.

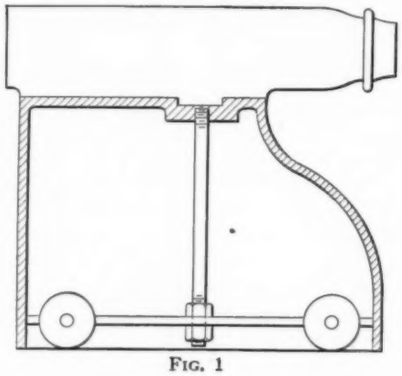


FIG. 1

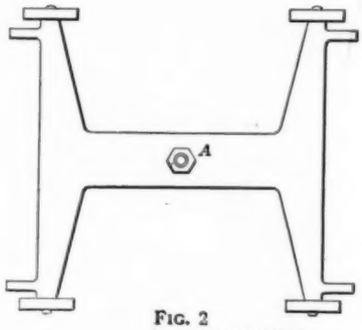


FIG. 2
American Machinist

MAKING THE TAILSTOCK MOVE EASILY

The lower portion of our tailstock was proportionately deeper than theirs, and cast box section on the main, like Fig. 1. Within this we put an H-shaped frame, as shown in Fig. 2, with four wheels at the ends of the arms as shown, this frame an easy fit in the box section. At practically the center of gravity of the tailstock we tapped in a screw as at *A*, and, with this screw, which practically becomes a jack screw, we jacked up the entire tailstock so as to carry about nine-tenths of the weight. The H-shaped casting was intentionally made rather light so as to act as a spring, so that while a large proportion of the weight is carried on the wheels, there is enough left unsupported to keep the sliding surfaces tight on the ways.

When the tailstock is raised the ways have to be thoroughly cleaned, or the dirt and chips would be caught under it, whereas, in our case, no such care has to be used, and besides, nothing has to be done, as it is always ready for action.

This satisfies the workmen much better than the pinion and crank plan. It is not particularly more expensive, and can be put in present lathes without having to do much work, either on the old lathe or the rig itself. When this cannot be introduced in some of the modern lathes, any scheme that can be devised that will permit an adjustable stiff spring over each wheel will do as well.

Syracuse, N. Y. JOHN E. SWEET.

The Shilling Rate for Wages

The writer of the interesting article on page 383 of the AMERICAN MACHINIST, on the early history of cold-punched nuts, raised the question as to whether or not some of the older methods were as good as those of today, and seemed to think that the shilling rate per day combined with a dollars and cents total in making up the payroll was the result of habit. I am inclined to think otherwise from the fact that I know of at least one manufacturing company in Rhode Island which was employing thousands of hands in 1893 and using that same combination in connection with the payroll calculations as a matter of convenience, and are probably doing so at the present time.

The rate in shillings per day is identical with dollars per week: 3 shillings per day = $3 per week; 4 shillings per day = $4 per week; 7½ shillings per day = $7.50 per week.

Compare the above with the following: 50 cents per day = $3 per week; 70 cents per day = $4.20 per week; $1.25 per day = $7.50 per week.

As a boy I used to wonder why it was that many of the country people used to reckon wages in shillings per day, while they used the regular decimal dollars-and-cents system for nearly all of their other financial calculations. I had outgrown my childhood some time before I discovered the solution of the matter.

Greenfield, Mass. A. L. GRAFFAM.

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American Machinist

Insufficient and Poorly Distributed Light in Shops

The proper lighting of shops is by no means an easy task, especially in crowded quarters, and it is a problem that has a wider bearing than may appear at first sight.

There is little doubt as to its effect on both the quantity and the quality of the work, either one being enough to warrant its receiving more study than it usually receives. But there are two other phases which cannot be ignored after they are once realized.

In his admirable paper on the prevention of accidents, John Calder pointed out the effect of poor lighting and showed that the number of accidents increased largely during the winter months, and during the hours of artificial lighting. Many of these accidents were from serious and often fatal falls.

A great cause of this is the concentration of light at a given point, perhaps on the work being done, leaving deep shadows around the machine and having a blinding effect when an operator suddenly turns away from the glare of the lights, only to find that he can see nothing in the surrounding gloom.

An ordinary incandescent lamp often gives several times as much light as daylight on the spot where it is centered, although this is rarely recognized. The same amount of light properly distributed, will often make a well lighted shop, but this is not an easy task to accomplish.

There is also another phase of the question which has not received proper attention because we are only just awakening to the fact that our problems are growing beyond the actual making and selling of the machines. The effect of insufficient light on the eyes of operatives is one of those problems that is just beginning to receive attention. Both the straining of the eye to read graduations either in a dim light or the glare of a lamp directly in the line of vision, are bad for the eyesight and are to be considered as a phase of production.

Machine building is particularly free from the occupational diseases which are all too common in some industries, but the impairment of eyesight from improper lighting can almost be placed under that heading.

General or diffused shop lighting is a serious problem in many cases, especially where the traveling crane demands great headroom and a clear space below it. But it is a problem that can be solved and should be welcomed by those who are looking for the worth-while things to do. Fortunately it is receiving more attention in many places, but universally good results can only be obtained by a widespread recognition that the problem really exists.

Limiting Initiative Reduces Efficiency

One objection often urged by systematizers against the suggestion box is that the shop becomes afflicted with "inventoritis," and that the bolt-cutter man neglects his own work in trying to tell the manager how to run the plant.

With a scientific time study we are hearing so much about, the bolt-cutter man is not apt to have much opportunity to neglect his own work in an endeavor to run the manager's job. If he is interested enough to think about it outside of working hours, it is highly commendable in every way. And it often happens that even the manager can get an idea from the bottom of the ladder.

There is a mushroom crop of so called efficiency engineers who believe so thoroughly that "every little movement has a meaning of its own" that they specify every motion of the operator for every minute of the day. Such men naturally contend that all an operator need know is how to follow his schedule, and they discourage any initiative whatever, believing the men who are hired to do the thinking must of necessity discover all the points worth thinking about. These men want no suggestions and they rarely get them—especially the second time.

Others would allow suggestions regarding their own department, but discourage them elsewhere. We do not believe that even such limitation is either wise or necessary. Just as it is always easier to see the mote in your brother's eye than the beam in your own, so it is often easier for an outsider to suggest better ways for the man who is so close to his work that he does not see where his methods are at fault.

And if men lose time by suggesting improvements for other departments, the motion-study man and the rate setter, to say nothing of the speed boss and the instructor, have all slipped a cog or two in the scientific-management train.

We have no quarrel with real efficiency engineering or with any movement which cuts out wasted effort, time or material, but we do not believe that permanent advancement of any industry can be attained by throttling initiative in even the lowest grade of employees, or by making the man a mere attachment to the machine.

No Monoply in Scientific Management

It is so easy to fall into the error of taking the shadow for the substance that even some of the technical papers drop by the wayside, and take us to task for attempting to oppose efficiency and scientific management.

Nothing could be further from the truth.

The aim of our existence is to improve the efficiency of workmen, of machines and of management. But we do seriously oppose the idea that any man or men have a monopoly on the only methods to be used and do not hesitate to condemn such features as appear undesirable, regardless of where they originate.

Metal Trades Convention

The thirteenth annual convention of the National Metal Trades Association was held at Hotel Astor, New York on April 12 and 13. The attendance was large and representative and the subjects before the convention show the broader trend in all problems of manufacturing which are being thought out and discussed in various parts of the country.

F. A. Geier, chairman of the Committee on Industrial Education, told of the work of his committee, of the many replies they had received from all sections, indorsing the movement for the better education of their apprentices by similar methods to those employed in Cincinnati. The general impression seems to be that the technical training or "book learning" as many still call it, can best be had in the great majority of cases by close cooperation with the public-school boards as is done in that city. The half-time plan and continuation plan both seem to fill a real need, the latter being applicable to a wider range than the former.

The experience of the Cincinnati manufacturers in this connection affords an example of what can be accomplished in almost any locality if a little united and determined effort is made. Headed by Mr. Quillen they presented their proposition to the school board so effectively that the plan was adopted and has been enlarged to accommodate more than apprentices.

When the machinists found that the boys were learning some things which they did not know but which were very useful in the shop, they petitioned for evening classes and later the foremen got into line, with the result that evening classes are now established for both on much the same plan as the day classes for boys.

Mr. Geier presented a strong plea for an active campaign in all quarters along this line, pointing out that such work could not fail to benefit not only the men and manufacturers directly involved but also have its effect in improving the citizenship of the whole community.

It was decided to give the executive board power to act in conjunction with this committee so as to inaugurate an active campaign of educating the boys, their parents and the manufacturers in various sections as to the desirability of the plan, and stir them into securing action by their local school boards.

Closely allied to this is the work of the Apprenticeship Committee, of which E. P. Bullard, Jr., is chairman. In his report Mr. Bullard advocated the same general form of apprenticeship as adopted by the National Machine Tool Builders' Association, and urged more care in the shop manual training of the boys in addition to the training of the schools along technical lines. Apprenticeship, to be effective, requires eternal vigilance and is a much broader subject than is sometimes thought. It was again pointed out that the best training that could be given to apprentices in shops was by having some one person delegated to counsel that training, in connection with which the following is quoted from the report: "Not only should this person have charge of the class of work that the young man should do, as well as place him in various departments of the works, but he should also have some opportunity to influence the intellectual and outside life of the young man. As has been said before, all shops are not large enough to afford paying a man to do this and nothing else; but there is no shop so small but that one of the journeymen could be detailed to give some portion of his time to the training of such young men. We are aware that we must advocate a system of apprenticeship that will apply to the majority of the owners of shops, and the majority does not consist of large but medium and small-sized shops. And so we hope that as you consider this work you will not pass it over and say that 'it is good for my neighbor; it does not fit my case; I am too small;' but that you will take it earnestly enough to see wherein you must modify it so that it will exactly fit your conditions."

Under the general heading of "Labor Efficiency Betterment," papers were presented by Messrs. Calder, Porter and Grieves. The first mentioned, who is manager of the Remington Typewriter Works, pointed out the different phases of the problem of industrial accidents along the same lines as his recent paper before the American Society of Mechanical Engineers, and urged that its consideration be made a part of the regular shop management.

Mr. Porter pointed out many of the neglected factors in the real cost of production which are usually overlooked. These included the health and character of the worker, both at the time he is hired and while he is employed in the plant. The much abused and exploited welfare work was brought out in its proper light as being really a part of efficient production instead of philanthropy, as it is too often considered. Mr. Grieves' paper gave the experience of the Jeffrey Manufacturing Company, of Columbus, Ohio, with so called welfare work, and pointed out many benefits and advantages to all concerned through a system of what he called "mutuality."

The importance of safeguarding machinery and methods of accident prevention was discussed in a very lively fashion by L. D. Burlingame, of the Brown & Sharpe Manufacturing Company, Frank Burgess, of the Boston Gear Works, and Dr. William J. Manning, medical officer of the Government Printing Office. W. F. Helmond briefly sketched the betterment work carried on by the Underwood Typewriter Company.

The question of employers' liability insurance occupied the Thursday morning session. William Butterworth's report of the committee was followed by vigorous discussion by Raynal C. Bolling, of the United States Steel Corporation, Miles M. Dawson, J. A. Macdonell, H. V. Mercer and others.

In the afternoon H. L. Gantt and Oberlin Smith gave their impressions of foreign shop methods. The careful study and attention to details which are evident in Germany, was pointed out as being largely responsible for the strides Germany has made in the industrial world.

Lewis Gustafson, superintendent of the John Ranken, Jr., school, of St. Louis, Mo., told of the methods employed in teaching the mechanical trades in that school.

The following officers were elected for the ensuing year: President, F. C. Caldwell, H. W. Caldwell & Son Company, Chicago, Ill.; first vice-president, Henry D. Sharpe, Brown & Sharpe Manufacturing Company, Providence, R. I.; second vice-president, W. A. Layman, Wagner Electric Manufacturing Company, St. Louis, Mo.; treasurer, Howard P. Eells, the Bucyrus Company, S. Milwaukee, Wis.

The Congress of Technology

The Congress of Technology, called to celebrate the fiftieth anniversary of the charter of the Massachusetts Institute of Technology, was held in Boston on April 10 and 11. The program included papers along the various lines of work taken up by the Institute, many of them from very prominent men and all being graduates of the Massachusetts Institute of Technology.

From among those in our own line of work we will extract a few which deal with the newer phases of the modern building industry. The papers presented a review of the application of science to the varied affairs of industrial life and show the progress that has been made during the past fifty years. These will appear in other columns as space permits.

Milling Cutters, Their Efficiency—I*

By A. L. DeLeeuw†

An account of a systematic series of experiments with cutters of greatly increased pitch which have given such favorable results as to lead to their adoption by the Cincinnati Milling Machine Company.

An account is also included of experiments with helical cutters of greatly increased helix angle.

*A paper to be presented at the spring meeting of the American Society of Mechanical Engineers.

†Mechanical engineer, the Cincinnati Milling Machine Company.

The amount of metal which a machine tool can remove in a given time is limited by the strains caused by the cut. Great hardness of the material to be cut, or a dull tool, will severely strain the machine and so reduce the section of the chip, even if the machine is rigidly constructed and well supplied with driving power. It is therefore of the greatest importance to analyze carefully all the conditions which cause heavy strains so that they may be obviated or reduced to the lowest possible limit.

This limitation of the cutting capacity occurs in all metal-cutting machines, although to a varying extent. While it is possible to increase the driving power of most machines *ad libitum*, and almost any amount of metal can be put into machine elements to give them rigidity, there are certain classes of machines where practical considerations limit such increase of power and strength. This is especially true in machines where the main elements have to be adjusted and handled with great frequency. The knee-and-column type of milling machine owes its success, to a large extent, to the ease and rapidity with which it can be manipulated and it is doubtful if it will ever be possible to increase the dimensions of the parts much beyond the present sizes, without losing the benefits of the peculiar construction of this type of machine. In order to increase the capacity of this type of milling machine, it becomes necessary to reduce the strains set up by the cut and there are only two elements which can be modified to accomplish this result. These are the hardness of the metal to be cut and the cutting qualities of the milling cutter. As it is impossible to control the first of these, the only avenue left for improvement leads in the direction of the milling cutter.

Experiments carried on at the works of the Cincinnati Milling Machine Company and extending over several years, starting with some isolated and almost desultory trials, and gradually becoming a series of carefully planned experiments, have led to results which are believed to be of general interest. These tests embraced spiral mills, end mills, both of the shell end-mill type and the spiral taper-shank type, side mills, slitting saws, face mills, and a new type of mill which for lack of a better name is called here a helical mill.

The Action of a Milling Cutter

The action of the ordinary milling cutter is not a true cutting action, as it is commonly understood. By a true cutting action is meant the driving of a wedge-shaped tool between the work and the chip and, although this definition is not based on a generally accepted meaning of the term, it is believed that it expresses fairly well what most mechanics understand by cutting. Practically all milling cutters have their teeth radial and this, of course, excludes the possibility of driving a wedge between chip and work. The tooth compresses the metal until it produces a strain great enough to cause a plane of cleavage at some angle with the direction of the cutter. It then begins to compress a new piece, push it off, and so on. This at least *seems* to be the action of the cutter, judging by the form of the chips. These chips are in the form of needles or small bars.

The chip taken by a milling cutter varies very materially from those taken by a lathe or planer tool. These latter tools make chips of uniform section, whereas the section of a milling chip increases from zero to a maximum.

Fig. 1 shows a milling chip as it would appear, if no compression or distortion took place. The proportions are very much exaggerated, so as to bring its typical shape clearer into view. The width *A B* at the top is equal to the feed per tooth. The hight *B C* is the depth of cut. The length *B D* is the width of cut. The section *M N O P*, shown half way on the chip, is a normal section and a measure of the amount of work which was done at the time the cutter passed the point *M*.

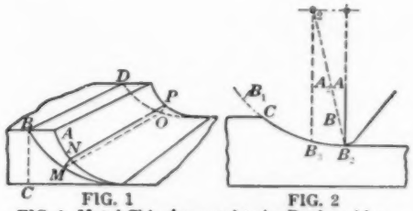


FIG. 1

FIG. 2

FIG. 1. Metal Chip Assumed to be Produced by Milling-Cutter without Distortion.
FIG. 2. Diagram to Illustrate Action of Milling Cutter.

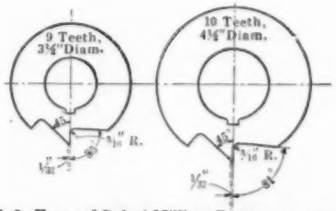
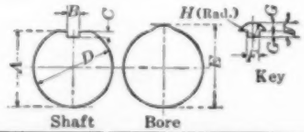


FIG. 3. Form of Spiral Milling-Cutters now used by the Cincinnati Milling Machine Company.



A	B	C	D	E	F	G	H
0.973672	9/32	9/64	1	1.05179	9/32	9/64	15/64
1.03779	9/32	9/64	1 5/16	1.11592	9/32	9/64	15/64
1.21875	5/16	5/32	1 3/4	1.3125	5/16	5/32	1/4
1.4543	1/4	1/8	1 3/8	1.5793	1/4	1/8	21/64
1.7111	1/4	1/8	1 7/8	1.8361	1/4	1/8	21/64
1.94734	5/16	5/32	2	2.10359	5/16	5/32	15/32

FIG. 5. Shape and Dimensions of Keys used for Milling-Cutter Arbors.

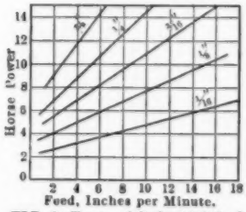


FIG. 6. Tests of Spiral Nicked Milling-Cutter 3 5/16" Diameter; 18 Teeth and about 5/16" Pitch. Cutting Cast Iron, Corrected for Hardness. Width of Cut 6".

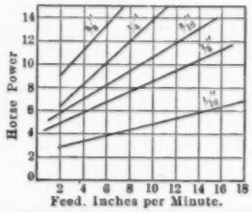


FIG. 7. Tests of Spiral Nicked Milling-Cutter 3 1/2 Diameter; 14 Teeth and about 3/4" Pitch. Cutting Cast Iron, Corrected for Hardness. Width of Cut 6".

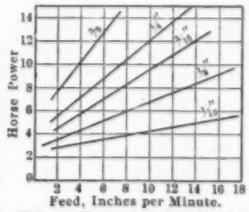


FIG. 8. Tests of Spiral Nicked Milling-Cutter 6" Diameter; 16 Teeth and about 1 1/4" Pitch. Cutting Cast Iron, Corrected for Hardness. Width of Cut 6".

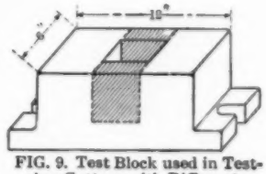


FIG. 9. Test Block used in Testing Cutters with Different Spacing of Teeth.

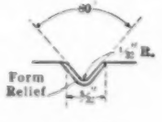


FIG. 10. Chip Breaker.

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Fig. 2 shows the action of a milling cutter, with center O, when the cutter is rotating and the work is feeding at the same time. The tooth $A\,B$ sweeps through the path $B\,C$. When the point B has reached the position B_1 a new tooth starts cutting. By this time O has advanced to position O_2, and the new tooth $A_2\,B_2$ is not yet in a vertical position, when the point B_2 touches the work. When the cutter revolves, this point B_2 must penetrate into the work and compress the metal of the work. The result will be spring in the arbor. When this spring has assumed certain proportions, the blade or tooth begins to remove a chip. This may be assumed to take place in the position B_3, the tooth simply gliding over the work from B_2 to B_3. This action must necessarily be very harmful to the cutter, and it was believed that this, perhaps more than any other action of the cutter, caused its dulling. It would be especially severe with light cuts, as a relatively small amount of spring would allow the point B_2 to travel through a large arc. It would be quite possible that a tooth should fail entirely to take a chip, and that the succeeding tooth would take a chip of double the amount.

This peculiar action of the milling cutter is inherent in its construction and cannot be avoided. The question then is how to minimize these harmful results.

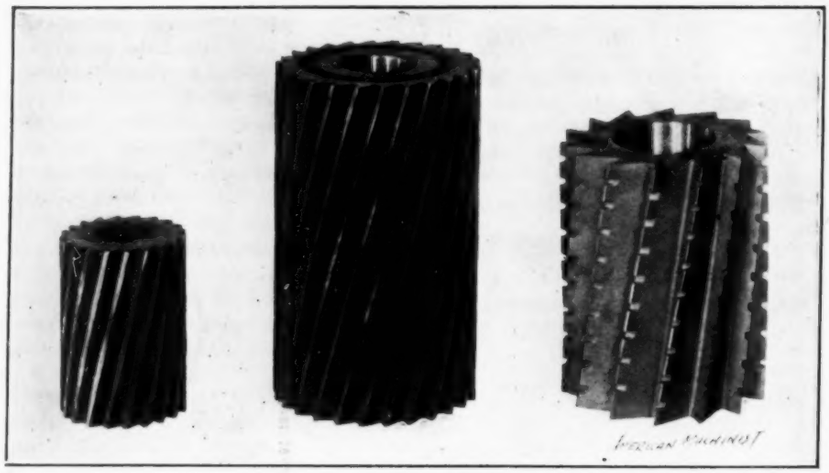

FIG. 4. COMPARISON OF OLD AND NEW STYLE SPIRAL MILLS

THE IMPORTANCE OF CHIP ROOM

Another feature, which limits the ability of a milling cutter to remove metal, is the proportion between the chip to be removed and the amount of space between two adjoining teeth. Such a limitation does not exist with lathe or planer tools, where the chips have unlimited space in which to flow off.

That this proportion between chip and chip space actually does form a limiting condition is well known and was brought most forcibly to the writer's attention when a large and powerful machine stalled, taking a cut in cast iron about 1½ inches wide, 3/16 inch deep and 12½ inches feed per minute. Several times this amount of metal can be easily removed by the same machine, without sign of stress; yet the machine was incapable of removing more than 3 cubic inches of cast iron per minute with this cut. Investigation showed that the amount of cast iron removed per tooth was sufficient to fill the chip space completely, and from that moment the action was like trying to push a solid bar of steel through a piece of cast iron. Another cutter, with more chip space, removed the same amount of metal with only a fraction of the power of the machine.

Similar instances occurred with gangs which had been in use a long time, and which had been ground down to such an extent that the chip space was materially reduced. This, combined with the fact that higher developed milling machines led the shop to coarser feeds, showed that the ability of the machine to remove metal was not only governed by its power, but to an equal extent by the peculiarities of the milling cutter.

FORM OF TOOTH IN THE NEW CUTTER

The foregoing considerations led to a gradual evolution of spiral milling cutters. At first, the number of teeth of spiral mills was only slightly diminished, as it was thought that some element which was not considered might affect the result. Gradually the spacing was increased and the cutters, as now used, have taken the forms shown in Figs. 3 and 4.

Two standard sizes are used, although other sizes are required for special cutters and special gangs. The standard diameters are 3½ inches and 4½ inches. The 3½-inch diameter cutters are made with nine, and the 4½-inch diameter cutters with ten teeth, which corresponds to a spacing of about 1¼ inches. The point of the tooth has a land of 1/32 inch, and the back of the tooth forms an angle of 45 degrees with the radial line. The chip space is approximately four times as great as in the usual standard cutter of the present time and is formed with a 3/16-inch radius at the bottom.

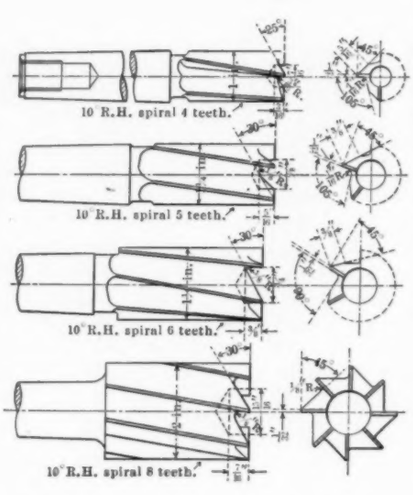

Fig. 11. New Type of Taper Shank End Mills

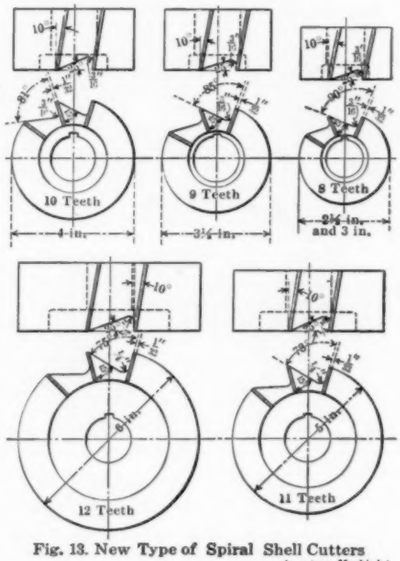

Fig. 13. New Type of Spiral Shell Cutters
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NEW TYPES OF TAPER-SHANK END MILLS AND SPIRAL-SHELL CUTTERS

SIZE AND CONSTRUCTION OF ARBORS

Though not directly connected with the foregoing, attention should be called to the fact that present practice calls for arbors which are too small. In the cutters shown here, the 3½-inch cutter is made with 1½-inch and 1¾-inch arbor, and the 4½-inch cutter with 1¾-inch and 2-inch arbor.

It is often very difficult to remove cutters from an arbor after they have done heavy work. It is frequently necessary in such cases to press the arbor out of the cutters. This sticking of the cutter is caused by the burring up of the key, and often the keyway in the arbor. For this reason, keys are used for gangs of cutters as shown in Fig. 5. A flat is milled on the arbor, and the keyway milled central with this flat. The flat portion of the key presses against the flat part of the arbor, and this effectively prevents burring. Cutters which are held on the arbor with such a key can always be very readily removed, even after prolonged and hard work. The keys are made out of a piece of round stock, grooved at both sides and then sawed apart.

Results of Tests

Very satisfactory results were obtained with these cutters. Figs. 6, 7 and 8 show the results of tests made with cutters with 5/8-in., 3/4-in. and 1 1/8-in. spacing. Cuts were taken on cast-iron test blocks as shown in Fig. 9. The cross-sectioned part of the test block was milled out. A series of tests was made on the left-hand half of the block with one kind of cutter and on the right-hand half with another cutter. It will be noticed that the same amount of power is required to take a cut 1/4 inch deep and with 10.4 feed with a cutter of 5/8-inch pitch; and a cut 1/4 inch deep and with 13.5 feed but with a cutter 1 1/8-inch pitch.

It was not safe to assume that all test blocks would be of the same hardness. In order to correct whatever error there might be on account of unequal hardness of the test blocks, hardness tests were made of the different blocks. These consisted in taking a cut 3/16 inch deep and with various feeds on each one of the blocks, and finally a check test on the first block, to make sure that the cutter had not appreciably dulled.

It will be seen from these diagrams that there is a large increase in the amount of metal which can be removed with the same amount of horsepower, by using these wide-spaced cutters; and that, therefore, the scope of the knee-and-column type of milling machine has been enlarged without increasing sizes or weight of parts and thus decreasing the handiness of the machines.

Other Advantages of the New Cutters

Though increased capacity for removing metal is one of the main advantages of this form of cutter, there are others of considerable importance. It was found that for roughing on the ordinary work in the shop a cutter with the wider-spaced teeth would remain sharp for a longer period, notwithstanding that feeds had been increased. The system of the Cincinnati Milling Machine Company requires all gangs and cutters to be resharpened after a lot of pieces has been milled. It used to be necessary, at least on the larger lots, to resharpen the gang once and sometimes twice for one lot, or, if this was not deemed advisable, the feed had to be reduced for at least part of the pieces, in order to make the cutter last during the entire lot. In all cases where the wide-spaced cutters were used, the entire lot was run through without resharpening the cutter or reducing the feed; and it should be kept in mind that this feed was from 25 to 100 per cent. greater than previously used. There is no case on record where the cutter or gang was dull at the end of the lot, so that our observations as to the endurance of the cutters are incomplete. However, it is perfectly safe to say, that in all cases under observation, the cutter maintained its sharpness longer; that in a great many cases double the amount of work could be done without resharpening; and that there is good reason to believe an even greater gain than this was obtained.

A further advantage is, that as these cutters have approximately only half the number of teeth of what is now considered a standard cutter, the time for resharpening is only half as much.

It was pointed out that the ratio pitch to depth is practically the same as in the present standard cutter, so that the depth of tooth is practically doubled and this cutter can be sharpened much more frequently than the present standard cutter. Consequently, the life of the cutter has been much increased, probably more than doubled.

A glance at the drawing of these cutters gives the impression that the teeth are weak and the writer has watched this feature with great care. The cutters themselves, however, do not give this impression; on the contrary, they look stout and well proportioned. They have been subjected to the heaviest class of work and many times were purposely abused in order to find their weak points; yet there is no case on record that any of them have broken although they have been used for more than two years and all breakages of cutters are carefully noted. On the other hand, breakages of the old cutters are not at all infrequent.

Though these cutters are capable of removing metal more rapidly than the older type of cutter there are many cases where this feature cannot be taken advantage of, as, for instance, where light work is to be done or a small amount of stock to be removed. In such cases, however, the metal is removed with less power and consequently with less strain on the machine and the life of the machine is lengthened without limiting its output.

The Action of the Feed

With the wide spacing of the teeth it may seem that there would be cause for apprehension as to the action of the feed. It seems as if the feed would be liable to act with jerks. This, however, is not the case. On the contrary, the feed is smoother and there is less of a jerk when the cutter first strikes the work, probably because there is less spring in the arbor and less tendency for the cutter to ride over the work, as will be explained later in connection with the description of cutters.

In connection with this, it is interesting to note that when cast iron is milled by

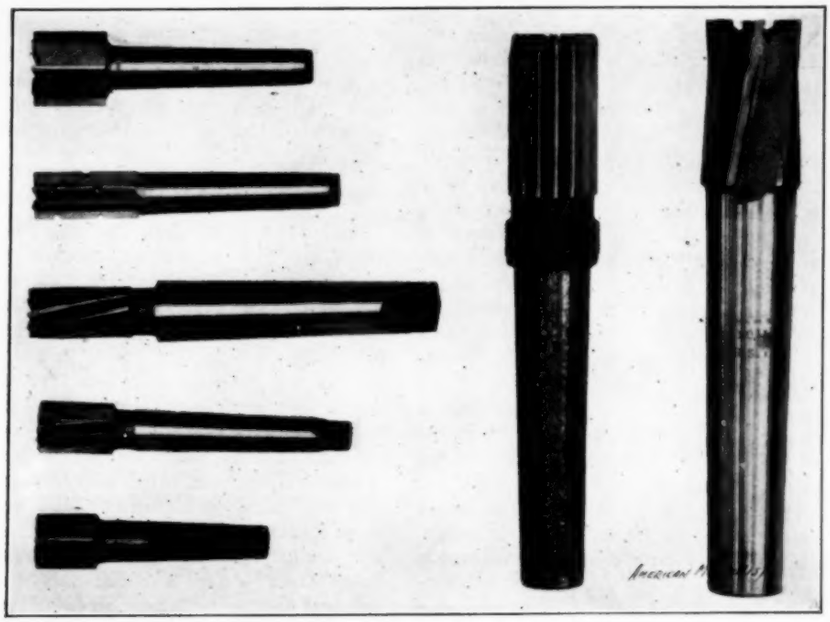


Fig. 12. Comparison of Old and New Style of End Mill

these wide-spaced cutters, it appears to be very soft and when the same piece is milled by an old-style cutter, it appears to be much harder. When using the wide-spaced cutter, there is a notable absence of jerking, chattering and of the peculiar singing noise which is so often noticed on milling machines.

There is, of course, a difference in the hardness of different pieces of cast iron, and many recommendations as to the proper feeds and speeds for milling cast-iron work, made by the writer for the his company, were looked at askance. The impression seemed to prevail that feeds and speeds which were possible on American iron, were out of the question on European iron (especially English and German); and again, that feeds and speeds proper for western American iron were not suitable for eastern iron. To test the truth of the matter, a number of bars of cast iron were obtained from different foundries in America, England, France and Germany. These bars covered a great many mixtures and makes, and the difference between English and American, or German and American iron, or between eastern American and western iron, was found to be no greater than that between different specimens of western American iron. Even German Spiegeleisen, famous for its hardness, cut just as freely as soft western iron, and required but little more power. However, it did require more clearance, wide spaces, and a low speed.

These wide-spaced cutters were originally intended for roughing operations only, but the very satisfactory finish obtained when roughing led to the use of the cutters for finishing also. If there is any difference at all in the finish produced, the advantage is on the side of the wide-spaced cutter. The fact that this wide-spaced cutter will cut a greater number of pieces without dulling, means, of course, that the average of an entire lot is better.

The Chip Breaker

It is generally believed that for finishing alone a milling cutter should be used without chip breakers, the effect of the chip breaker being to scratch the surface. To overcome this trouble, chip breakers are made as shown in Fig. 10 with clearance at both corners. This prevents the tearing up of metal with the result that a cutter with these chip breakers produces as good a finish as one without chip breakers.

It should be pointed out that this form of chip breaker has an advantage also for roughing cuts. The point of the cutter, where the unrelieved side of the chip breaker drags over the work, is the first point to give out. Making the chip breaker with clearance on both edges prolongs, therefore, the life of the cutter.

One of the great advantages of this form of chip breaker is, that one gang can be used for both roughing and finishing. A great many, if not most milling operations, call for two chuckings, one for roughing, and one for finishing. This will be found to be necessary wherever much metal is to be removed, on account of distortion caused by the cut, the heavy clamping required, heating, spring of arbor or fixture and the unbalanced condition of the work after the scale has been removed on one side. In order to do the roughing as rapidly as possible chip breakers are required; and in order to get proper finish, it has heretofore been necessary that the finishing gang be without chip breakers. It paid, therefore, to have two gangs whenever the number of pieces to be milled was sufficiently large, but this involved considerable extra expense for cutters. The new form of chip breaker, however, permits using one gang for both finishing and roughing.

The Finish of the Work

It is a common belief that better finish can be obtained with teeth closely spaced, but experience with the wide-spaced cutter shows that there is no ground for this belief. The grade of finish may be expressed by the distance between successive marks on the work. These marks are revolution marks and not tooth marks. It is practically impossible to avoid these revolution marks. They are caused by the cutter not being exactly round or quite concentric with the hole, by the hole not being of exactly the same size as the arbor, by the arbor not being round, by the straight part of the arbor not being concentric with the taper shank, by the taper shank not being round or of the same taper exactly as the taper hole in the spindle, by this taper hole being out of line with the spindle, by looseness between the spindle and its bearings, etc. Each of these items is very small in any good milling machine; yet the accumulation of these little errors is sufficient to cause a mark and this mark needs to have a depth of only a fraction of a thousandth of an inch to be very plainly visible. As these marks are caused by conditions which return once for every revolution of the cutter, it is plain that the spacing of the teeth can have no effect on the distance between them and, therefore, on the grade of finish.

To test this still further, two cutters of the same size exactly were placed side by side on an arbor. The cutters were ground together so as to be sure they were of equal diameter and they were ground on the arbor so as to be sure that the error would appear simultaneously for both cutters. A block of cast iron was finish-milled with these cutters in such a way that each cutter would sweep half the width of the block. The same number of marks appeared on both sides of the block, and these marks were exactly in line with each other, as might have been expected. The grade of finish was the same for both sides. It was neglected to mark the two sides of the casting to show which cutter was operating. After this test, all of the teeth but one of one of the two cutters were ground lower, so as to be out of action entirely, leaving only one tooth of the one cutter operative. Another cut like the first one was taken over the same block, and again the finish appeared the same on both sides. There was a difference of opinion between different observers as to which side was cut by the single tooth. By close observation, however, a difference could be detected when light fell on the work in a certain direction, under which conditions one side showed more gloss than the other. Straightness, flatness and smoothness to the touch were exactly the same for both sides, notwithstanding that one cutter had one tooth only and the other fourteen teeth. Though it is not recommended here to use cutters with one tooth only for finishing, the foregoing test shows plainly that there is no merit in fine spacing. Attention is again called to the fact, that even though the finish on a single piece *might* be better with more teeth in action, the *average* finish for an entire lot of pieces is better with less teeth.

End Mills

Figs. 11 and 12 show the end mills which are now considered standard by the Cincinnati Milling Machine Company and which fill practically all requirements. They are made in sizes of 1 inch, 1¼ inches, 1½ inches and 2 inches in diamter, the smallest with four, and the largest with eight teeth. It will be noticed that in order to preserve the strength of the teeth it is necessary to mill the back of the teeth of the three smaller sizes with two faces. A number of tests have been made with these cutters, but no comparative tests as to power consumption. Their action is remarkably free. This was clearly demonstrated by the following experiment: A 2-inch taper shank end mill milled a slot 1 1/16 inches deep in a solid block of cast iron at a rate of 6 inches per minute. The block was clamped to the table of the milling machine and the knee was fed upward. Under these conditions the chips did not free themselves from the cutter, but were carried around and ground up. The cutter was cutting over half its circumference. These two conditions combined make the task for the milling cutter about as difficult as is imaginable. There was, however, no sign of choking and the power consumption was not higher than it would have been with a spiral mill under ordinary conditions. The same cutter would remove from the end of the casting a section 1½ inches wide and 1½ inches deep. Under those conditions, the chips would free themselves from the cutter and these chips were rolled up in

pieces much like the chips obtained from a broad planer tool, when taking a finishing cut. This cut was taken with a feed of 11 inches per minute. Another similar cut, but 1 inch and 1⅛ inches in section was taken with a feed of 33 inches per minute. Similar, though much lighter cuts were taken with ordinary end mills, and in the same piece of cast iron. Again the cast iron seemed to be very hard, and became glossy when cut with an ordinary cutter, but appeared to be soft when cut with the wide-spaced cutter.

Fig. 13 shows the shell end mills of the wide-spaced type, which are now considered standard for their use by the Cincinnati Milling Machine Company.

The Natural Increase in the Ratio of Burden to Labor*

By James B. Stanwood†

In all manufacturing processes in the determination of the cost of the finished article, it is usual to divide it into three elements—the cost of the material used, the cost of the labor that can be charged to the conversion of this material into the finished product, and the amount of the burden, or overhead expense. This burden includes the cost of all other expenditures of labor and material necessary for carrying on the processes of production, which are general in their character, and which cannot be charged directly to any portion of the actual labor or material. In this connection the cost of selling the product should not be neglected, but should be considered a part of the burden.

As a result of the constant improvement in machinery and processes, or to use a popular phrase, because of the increase in "labor-saving devices," it can be stated as a law that: The ratio of burden to labor naturally tends to increase from year to year or period to period as industry progresses.

This can be shown by an illustration: Let the material, labor and burden in a given process be equally divided so that each has a unit value of 2, then the total cost is 2 plus 2 plus 2 equals 6, the burden-labor ratio being $\frac{2}{2}$ equals 1. If now by an improved machine, or by an improved process the labor is cut in half, then the total cost becomes 2 plus 1 plus 2 equals 5, and the burden-labor ratio will be $\frac{2}{1}$ equals 2. This is on the assumption that no other change has been made than that of cutting the labor in two. Let us consider a different set of values, in which the material is assumed to be 2, labor 12 and burden 6. The total cost then becomes 2 plus 12 plus 6 equals 20, and the burden-labor ratio is $\frac{6}{12}$ equals ½. Suppose that an improved process or machine now reduces the labor from 12 to 3, a rather uncommon experience; now the total cost becomes 2 plus 3 plus 6 equals 11, and the burden-labor ratio is $\frac{6}{3}$ equals 2. The saving in total cost is 45 per cent., but the burden-labor ratio is increased fourfold.

In many cases in practice the saving in labor as outlined in these examples is brought about by the introduction of some new device or machine which is sold generally to the trade so that it is open to all manufacturers to secure the benefit of this improvement, but it also usually happens that the competition among manufacturers gives most of this benefit to the consumer, and after a short period all the manufacturers are practically on the same basis, using the same grade of materials, the same type of tools and employing labor at about the same cost.

If this law of the natural increase of burden-labor ratio is not recognized, it follows that manufacturers who base their cost estimates on previously ascertained burden-labor ratios find themselves in the position of selling their goods at a low margin of profit, or no profit, or even at a loss.

The two examples here given assume that the total burden itself does not in any way increase or decrease absolutely; on the other hand, in many instances where improved machines or appliances are employed the total burden itself actually *does* increase. More elaborate machinery calls for greater care for upkeep and for a greater depreciation. It frequently follows that, although the net cost of the product is greatly reduced by a saving in labor, yet this entire saving in labor is not realized on account of an actual increase in burden.

A prominent manufacturer recently stated to the writer that the use of high-speed steel greatly increased his burden labor ratio over the use of the older steels. This, of course, is due to the reduction in labor cost which the high-speed steel effected, but in addition the increased cost of this steel and the increased cost in the upkeep and the depreciation of machines required to use this steel, also increase the actual burden; the net manufacturing cost, however, has been greatly reduced by the use of these improved cutting metals.

The reduction in the labor cost of an article as shown above cheapens it to the manufacturer and, ultimately with free competition among the manufacturers, cheapens it to the consumer.

In conclusion it may properly be suggested that a scientific study of the cost of burden is an undertaking that promises the attainment of new economies; for great reductions are possible in the cost of administration, and operation of buying and selling, and in the maintenance and depreciation of plant. Thus in striving for more efficient production, burden-saving methods are fully as valuable as labor-saving devices.

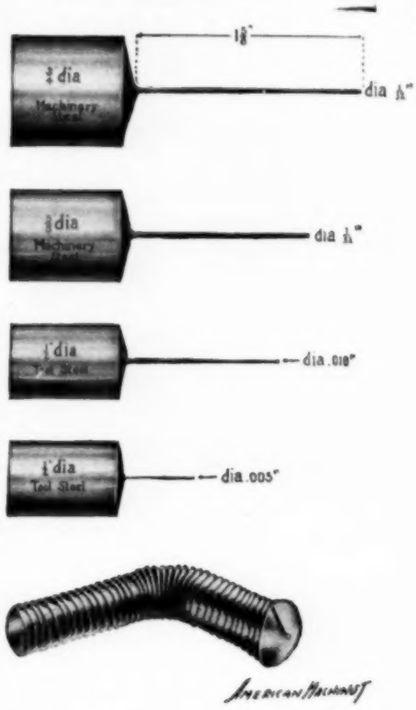
*Extract of a paper presented before the Congress of Technology.

†Vice-president and engineer, the Houston, Stanwood & Gamble Company, Cincinnati, O.

Precision Lathe Work

We are very apt to think of precision lathes as being only suited for taking very small chips, and it is somewhat of a surprise to see the illustration showing the ends of four bars recently turned in a Rivett lathe. This gives an extremely good idea of the stiffness of the lathe spindle and the general capabilities of the lathe.

The two upper bars are of machinery steel, while the lower ones are of tool steel, each being reduced at one cut. One



Heavy Work for a Precision Lathe

of the chips is shown at the bottom of the illustration.

When we consider a piece of ¾-in. machinery steel projecting at least 1¾ inches from the chuck, being turned at a single cut so as to leave a core of but 1/32 inch in diameter, we realize that there could be no lost motion in the bearings and that the tool must have been rigidly supported.

In the cases of the tool-steel bars, the cores of 0.005 in. and 0.010 inch, respectively, are extremely interesting and give an exceptionally good idea of the rigidity with which the work is held and of what can be done on one of these lathes. We are indebted to the Rivett Lathe Manufacturing Company, Brighton, Mass., for the illustration and information.

Shop Equipment News

The Erb Dial Test Indicator

The E. M. Erb Manufacturing Company, Jersey City, N. J., is manufacturing a test indicator, shown herewith. *A*, Fig. 1, shows a front view of the indicator with dial removed and *B* is a back view, while Fig. 2 shows the details of the mechanism.

The face is covered with celluloid instead of the usual watch crystal and a noticeable feature is that the indicating spindle has a shoulder on it which prevents its being accidentally forced in too far and injuring the mechanism. The indicating hand is operated by a small coil spring and a steel tape running around a drum and over a pivoted sector to the indicating spindle, which is forced outward by a spiral spring in the barrel.

FIG. 1. INSIDE, FRONT AND BACK VIEW OF DIAL TEST INDICATOR

At *A*, Fig. 3, is shown the way these indicators are tested for accuracy, being clamped into a block carrying a micrometer head, the spindle of which is in direct line with and against the end of the indicator spindle. The accuracy of each division on the dial is thus checked up by the micrometer reading for both forward and backward movements. After the first test, the indicator is placed in a lathe tool post with the contact point against a mandrel placed between the centers, which is 0.05 eccentric and runs at 1200 revolutions per minute. Tested in this way for two minutes the indicator is again tried with the micrometer.

At *B* is shown the method of using the indicator in a bench lathe and at *C* in a milling machine, the stem of the indicator, set into a split block being clamped between collars on the arbor. For special jig, or other work on a milling machine or elsewhere, an indicator having a dial on both sides is made, and a special point for inside use is made which multiplies the reading of the dial by two.

Cut *D*, Fig. 3, shows the instrument used in a shaper to line up the vise jaws, and all of the views illustrate the convenience of the tool for getting into difficult positions.

For all-around shop use this indicator fits in well, as its simple mechanism and compact case make it little liable to injury, while by its ease of adjustment, slight inaccuracies from any cause are quickly remedied. It was used for over two years, previous to being put on the market, by the manufacturer in his own shop on punch and die work requiring an unusual degree of accuracy.

ANY and all new or improved machines, tools or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here — the machine shop news.
A more full and detailed description will be given — when it is real news — if it can appear here first — before it is sent to other papers. ALL descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German

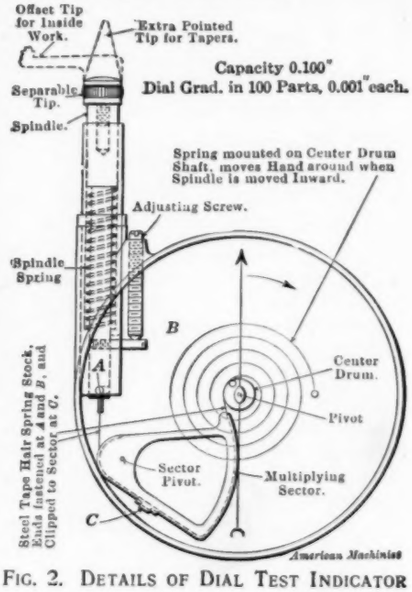


FIG. 2. DETAILS OF DIAL TEST INDICATOR

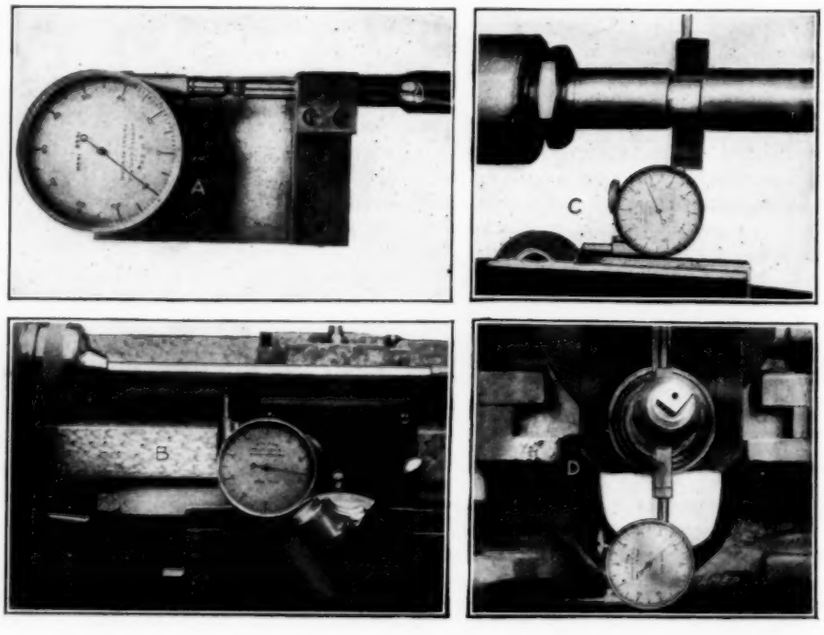


FIG. 3. THE WAY DIAL INDICATORS ARE TESTED AND SOME OF THE WAYS THEY MAY BE USED

Center Finder

The center finder shown herewith devised for time saving in lathe work has a socket that fits on the 60-degree angle taper of center in tailstock of the lathe. When held in that position and fed up to work held and revolving in lathe chuck it immediately locates the center. The friction of the center finder on the lathe

PECK CENTER FINDER

center is sufficient to hold for drilling and countersinking. Each center finder is sent out with a combination drill and countersink which are stock sizes with many makers. The Nos. 0 and 1 have a short-length single-end drill and countersink about half the length of the double-end ones on the market, for the sake of compactness; the double-end ones may, however, be used. The No. 2 and No. 3 are supplied with the regular double-end combination drill and countersink.

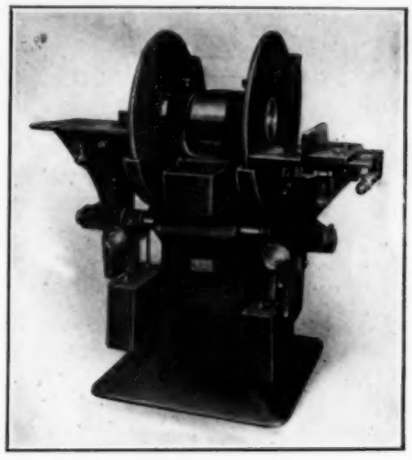
This tool is manufactured by W. A. Peck, 141 Brewery street, New Haven, Conn.

Ball Bearing Disk Grinder

The accompanying halftone shows a new disk grinder, an important feature of which is the mounting of the spindle in ball bearings of the Hess-Bright type. The ball races are constantly supplied with lubricating grease through a cup over each bearing.

Both tables are counterbalanced for convenience in making vertical adjustments and have a rocking motion across the face or disk, or can be fastened in a stationary position. They also have an angular adjustment to the face of the disk. The right-hand table has a sliding motion to and from the disk, operated by hand lever, and controlled by an adjustable stop screw graduated in thousandths of an inch. This table is also provided with two tee slots for fastening suitable angle plates, or fixtures for the work in hand. The left-hand table has an adjustable gage for angular work on the horizontal plane.

Another important feature of the machine is a self-contained exhauster attached to the back. It is driven from the countershaft, exhausting sparks and dirt from the disk guards through the pedestal, discharging into a removable water box under the exhauster.



BALL-BEARING DISK GRINDER

The machine shown carries disks 26 inches diameter, has a spindle pulley 8x 5½ inches, a vertical adjustment of 7½ inches and is manufactured by the Rowbottom Machine Company, Waterville, Conn.

Increasing Shop Capacities

METAL WORKING

NEW ENGLAND

John J. Adams, Worcester, Mass., will build a new machine shop.

Wilkinson Brothers will build a new garage on Wisteria street, Salem, Mass.

A one-story factory will be erected by the Westerly Jewelry Company, of West Mystic, Conn.

P. D. Sargent, South Weymouth, Mass., is in the market for a 12-inch swing bench lathe.

Jos. Wright, manager of Leicester (Mass.) Inn garage, intends to equip a new and larger garage.

The International Silver Company, Shelton, Conn., is to erect a two-story addition to its factory B.

The Bath (Me.) Iron Works will erect a new foundry. Will be in the market for new equipment.

The garage owned by the Brockway-Smith Corporation, at Charleston, Mass., was destroyed by fire.

The Wright Wire Company, Worcester, Mass., contemplates erecting a plant at Palmer, Mass.

J. F. Foster, 166 Devonshire street, Boston, Mass., is in the market for a 22-inch by 12-foot engine lathe.

The Hersey Manufacturing Company, manufacturing water meters, is erecting a new factory at South Boston, Mass.

John J. Adams, of Worcester, Mass., shoe-machine manufacturer, will erect a new building to be used for a machine shop.

News items for the sales department — where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip — facts

The Wolk-Gertsacov Jewelry Company, Providence, R. I., has been capitalized at $15,000 and will locate a plant in that city.

The round house, car shops and carpenter shop of the Boston & Maine Railroad, at Sanbornville, N. H., were destroyed by fire. Loss, about $40,000.

The Standard Brass and Copper Tube Company, of New London, Conn., proposes to enlarge its plant and has increased its capital stock to $75,000.

The factory of the Dane Machine Company, of Salem, Mass., collapsed, wrecking the building. The concern manufactures leather machinery.

P. J. Flannery Company, New Britain, Conn., incorporated with a capital stock of $50,000, will engage in manufacture of plumbing supplies in that city.

The Yale Iron and Stair Company has been organized and will establish works at West Haven, Conn. A new factory will be erected and equipped with modern machinery.

The plant of the Chas. Greiner Company, making riveting and spinning machines, New Haven, Conn., was destroyed by fire. The company is arranging to get into operation at once and hope to be ready for business in a short time.

MIDDLE STATES

Garage of F. R. Blackmore, Cleveland, Ohio, was destroyed by fire.

The Joliet (Ill.) Steel Construction Company will enlarge its plant.

The Baker Motor Vehicle Company, Cleveland, Ohio, is to build a large garage.

Laahs Brothers, of Appleton, Wis., will put up a rendering plant at Wausau, Wis.

The Lake Shore Railway will construct two more machine shops at Ashtabula, Ohio.

The Erie Railroad is planning to move its machine shop from Kent, Ohio, to another city.

Nordyke & Marmon Company, Indianapolis, Ind., will build an addition to its automobile plant.

Tioga Steel and Iron Company, Philadelphia, Penn., will build an addition to its plant.

Part of the plant of the Camden (N. J.) Iron Works was destroyed by fire. Loss, $50,000.

F. Storsberg, Newark, N. J., manufacturing gas and electric-light fixtures, will erect an addition.

The plant of the Florence (N. J.) Iron Works was damaged by a cyclone to the extent of $5000.

A machine shop is being built for the Trussed Concrete and Steel Company, at Youngstown, Ohio.

The Aluminum Goods Manufacturing Company will erect a four-story addition to its plant at Manitowoc, Wis.

Victor J. Humbrecht, Yardley, Penn., is having plans prepared for the erection of a garage, with machine shop.

W. M. Easterbrook, Philadelphia, Penn., has been issued a permit to build a one-story machine shop to cost $2000.

The Pennsylvania Railroad is planning repair and car sheds on property it recently acquired at Toledo, Ohio.

James H. Knoll, Reading, Penn., manufacturer of washing machines, will erect a new factory at 124-134 Maple street.

At Fremont, Ohio, the Jackson Knife and Shear Company has started a large addition to its plant on West State street.

The International Harvester Company will erect a six-story machine shop on Park avenue, near Fifteenth street, Milwaukee, Wis.

The Elmer P. Morris Company, Elizabethtown, Penn., manufacturing railway material, is making preparations to locate in Freedrick, Md.

The Union Steel Castings Company, Pittsburg, Penn., has commenced the erection of an addition, which will double its present plant.

The plant of the Philadelphia (Penn.) Metal Stamping Company, 2213 Chestnut street, was damaged by fire to the extent of $3000.

The Hupp Motor Car Company, of Detroit, Mich., will open a manufacturing plant at Windsor, Canada, for the manufacture of automobiles.

The Standard Tool Company, Cleveland, Ohio, has increased its capital from $1,000,000 to $1,500,000. Improvements will be made soon.

The Lanston Monotype Machine Company, Philadelphia, Penn., will occupy a new building to be erected at Twenty-fourth and Locust streets.

The Eldridge Company, Philadelphia, Penn., distributors of the Garfield truck, will lease the garage building about to be built at 1617 North street.

F. R. Fribley, of Bourbon, Ind., has just erected a new garage and machine shop and expects to equip it completely with all modern machinery.

The Wetmore Adding Machine Company, of Milwaukee, Wis., will locate a factory at Detroit, Mich. Offices have been opened in the Ford building.

It is reported that the amount which the Ontario & Western Railroad will expend on additions to its shops in Middletown, N. Y., will reach $250,000.

The National Radiator Company, of Johnstown, Penn., has bought the Oliphant Steel and Iron Company, Trenton, N. J., and is reconstructing plant.

The Eagle Manufacturing Company, Kansas City, Mo., will move its plant to Muskogee, Okla. The company manufactures agricultural implements.

The Economy Switch Box Manufacturing Company, Cleveland, Ohio, has increased its capital from $5000 to $25,000. Some new equipment will be placed.

The Acklin Stamping Company, Toledo, Ohio, has taken out a building permit for the erection of a new factory for the manufacture of metal-stamping devices.

Hetherington & Berner, Indianapolis, Ind., structural iron workers, are building a new machine shop and will install some new electric motors and appliances.

The Toledo (Ohio) Metal Furniture Company has taken out a permit for the erection of an addition to allow space for further development in the business.

The Niagara Radiator and Boiler Company, of North Tonawanda, N. Y., intends remodeling its whole plant in the immediate future, at an approximate cost of $100,000.

The New York & Stamford Railroad Company has awarded contract for the erection of additions to its plant at Port Chester, N. Y., including new machine shop.

The Chisholm & Moore Manufacturing Company, Cleveland, Ohio, has taken out a permit for an addition to its plant. The firm manufactures chain hoists, trolleys, etc.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids May 16, for 11 forging presses for Puget Sound navy yard as per Schedule No. 3475.

A building permit has been taken out by the Willys-Overland Company, Toledo, Ohio, for the erection of an addition to its present automobile plant, the new building to cost $15,000.

The Bonnell Manufacturing Company, Cleveland, Ohio, has been incorporated with $25,000 capital to manufacture and sell machinery and electrical devices by Edgar H. Pahn, Geo. S. Myers, M. M. Roche, etc.

The Brookside Machine and Repair Company, Cleveland, Ohio, has been incorporated with $10,000 capital to do a machine-manufacturing and repair business. Incorporators, M. Thebold, C. Marquard and S. E. Wese.

The J. B. Wise Company, of Watertown, N. Y., manufacturing principally brass nickel-plated pipe and plumbing specialties, is planning to equip a new brass rolling mill, which will necessitate considerable new machinery.

American Automatic Service Company, Camden, N. J., has been incorporated with a capital of $500,000 to manufacture automatic machines. Incorporators, Chas. P. Halyburton, S. R. Leap, Jr., M. C. Kirkbride.

The Finished Parts Manufacturing Company, Newark, N. J., has been incorporated with $15,000 capital to manufacture dies, die castings, patterns, etc. Incorporators, Jas. P. Callender, Albert W. Gray, Henry F. Merriam.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids May 2, for lathe for Portsmouth navy yard as per Schedule 3484 and crank-shaft lathe for Norfolk navy yard as per Schedule No. 3485.

The Vannette Bobbinless Sewing Machine Company, Amsterdam, N. Y., has been incorporated to manufacture sewing machines. Capital, $250,000. Incorporators, Chas. C. Washburn, W. W. Dickson, Thos. Starkweather, etc.

The Bremen Manufacturing Company, which will manufacture a new patent calorie engine for pumping purposes, has been organized and will operate a new plant at Bremen, Ohio. W. S. Turner is president; H. E. Young, general manager.

The Scudder Manufacturing Company, Columbus, Ohio, has been organized to manufacture and sell all kinds of automobile supplies and accessories. Incorporators, W. R. Scudder, G. L. Hempy, E. H. Mercer, etc. Capital, $15,000.

The New York Heater and Supply Company, Jersey City, N. J., has been organized with $50,000 capital by Wm. H. Goff, Norman E. Wiggins, M. C. Duane. The company will engage as mechanical engineers, brass founders, boiler makers, etc.

The Inter-State Supply Company, Toledo, Ohio, with a capital of $10,000, has been incorporated by C. D. Pettingell, Fred H. Kruse, Jennie Samsen, W. J. Fritsche and Mark Winchester, for the purpose of manufacturing automobiles and automobile parts.

The Stuebing Company, Cincinnati, Ohio, has been formed with a capital of $25,000 to manufacture and assemble automatic tire mounting machinery and other machinery. Incorporators, Wm. Stuebing, Walter A. Steubing, Edward Stuebling, Oliver G. Baily and W. H. Cobb, Ja.

The Lippard-Stewart Motor Truck Company has been incorporated with $350,000 capital and will erect a plant at Buffalo, N. Y. Temporary offices are at 851 Ellicott square. Thos. R. Lippard and R. G. Stewart, both formerly connected with the Franklin Automobile Company, are the organizers.

WEST OF THE MISSISSIPPI

Philip Pogreba will erect a blacksmith shop at Delano, Minn.

D. J. Wilson, Lewiston, Idaho, is planning to build a box factory.

Wm. Russell's blacksmith shop, at Luther, Ia., was destroyed by fire.

The Cavour Mining Company, of Buhl, Minn., will erect a machine shop.

E. J. Roberts, Spokane, Wash., will build a commercial garage and repair shop.

Thos. Vogitance, of Dodge, Neb., will erect a blacksmith shop at West Point, Neb.

Ivie & Payne, Sheridan, Ore., will build a new commercial garage and repair shop.

J. L. Strang, Euclid avenue, Spokane, Wash., has taken out a permit to erect a car shop.

A. R. Berck, of Hastings, Neb., will erect a plant to manufacture copper cable lightning rods.

The Anderson Furnace Works, Salem, Ore., is planning to increase the capacity of its plant.

The board of education, Terrell, Texas, is planning to install manual-training equipment in the city high school.

J. E. Hosmer, Silverton, Ore., is planning to build a plant for the manufacture of a garden-cultivating machine.

Scott V. Davis, Medford, Ore., will build a new commercial garage and repair shop. Modern equipment will be installed.

R. F. Booth, Seattle, Wash., is having plans prepared for a commercial garage and repair shop. Modern equipment will be installed.

The Macomber Rotary Engine Company, Aliso street, Los Angeles, Cal., is contemplating the erection of a factory at Santa Ana.

The Western Boiler and Steel Company has been incorporated at Los Angeles, Cal., by G. W. Darby and D. M. Ward, with a capital stock of $50,000.

The Porterville North Eastern Railroad, Porterville, Cal., is having plans prepared by its engineering department for new shops to be erected in this section.

E. B. Zane, Spokane, Wash., agent for the Packard automobile, will build a large commercial garage and repair station. A complete machine shop is included.

The Sunset Loan and Automobile Company, Los Angeles, Cal., will fully equip its large repair shop with all necessary machinery. The building is now being completed.

The Chicago, Milwaukee & Puget Sound Railroad, Tacoma, Wash., will build new shops in this city. One will be used for coach and car work, the other for general repairs.

The Star Drilling Machine Company, Akron, Ohio, has purchased property in the Floral Park section, near Los Angeles, Cal., and will erect a large factory for the manufacture of its drilling machinery.

The Riverside Steel Foundry Company, Riverside, Cal., recently incorporated, has taken out a permit to build a plant. It will

be the first of a series to be erected by the company. J. J. Evans is manager.

William E. Guy, of St. Louis, Mo., and associates, are forming a company for the purpose of establishing a $350,000 steel-rolling mill in St. Louis or East St. Louis. Mr. Guy was formerly with the Republic Iron and Steel Company.

The Brassington-Stoneham Company, Los Angeles, Cal., manufacturers of pumping machinery, will establish a plant on Central avenue. It will be equipped with machinery for the manufacture of its specialty, with a large machine shop for general work.

CANADA

The Dunning Sheet and Metal Works, of Ottawa, will build a large new factory.

The Acme Electric Appliance Company, of Brantford, Ont., will locate a plant there.

The Aluminum and Crown Stopper Company are building a large new factory in Toronto.

H. H. Williams, of Toronto, is head of the General Machinery Company, which will locate a plant there.

The Carette Kirk Company, manufacturers of plumbers' supplies, will locate a new plant at St. Boniface, Man.

The British Columbia Steel Corporation, of Vancouver, B. C., will buy large quantities of machinery for its immense new plant there.

The Gillette Safety Razor Company is about to erect a new six-story factory building for the manufacture of its safety razors, at Montreal, Canada. Plans are now being prepared by Lockwood, Greene & Co., of Boston, Mass.

General Manufacturing

NEW ENGLAND

Uxbridge, Mass., will extend its water system.

Brewer, Me., will build a new pumping station.

Ashland, Mass., will build a new pumping station.

Chesterfield, Mass., contemplates building a new power plant.

Somersworth, N. H., will erect a municipal electric-light plant.

Dublin, N. H., is contemplating the purchase of a stone crusher.

Andover, Mass., will spend $20,000 on improving its water system.

The Westport Water Company, Westport, Conn., will install a boiler.

Wm. Skinner & Sons, Holyoke, Mass., will erect an additional silk mill.

Springfield, Mass., will make improvements in its municipal power house.

William Engel & Co., Orono, Me., contemplate installing a steam plant.

Crocker & Burbank Company, of Fitchburg, Mass., will build a new paper mill.

The shop of Louis Romfer, cabinet maker, New Haven, Conn., destroyed by fire.

The Worcester (Mass. Cold Storage Company will erect a three-story addition.

The Standard Fabric Company, Fall River, Mass., will install a boiler and engine.

E. A. Baxter, Hyannis, Mass., contemplates installing a 2500-light generating plant.

The Portland Company, Portland, Me., is in the market for electrical equipment.

The New London (Conn.) Gas and Electric Light Company will make improvements.

The Hutchins Organ Company will build a new four-story factory at Waltham, Mass.

H. E. Prescott, Allston, Mass., is in the market for a 15-horsepower gasolene engine.

Chicopee, Mass., has appropriated $73,000 for improvements in its electric-lighting plant.

The Salem (Mass.) Gaslight is to erect two new buildings for the manufacture of water gas.

The Central Ice Manufacturing Company, Boston, Mass., will install a boiler and engine.

The Middletown (Conn.) Electric Light Company will make improvements in its plant.

The plant of the Columbian Canning Company, Lubec, Me., was destroyed by fire. Loss, $35,000.

The Boston Elevated Railroad, Boston, Mass., will install boilers, turbines and accessories.

Winship-Boit & Co., Wakefield, Mass., are to install new bleaching machinery in their new dyehouse.

The Goetz Silk Manufacturing Company, Holyoke, Mass., will build a new mill. Will use electricity.

The sawmill and machinery owned by Proctor Brothers, of Hanover, N. H., was destroyed by fire.

The plant of the Hawthorne Company, carriage manufacturer, New Haven, Conn., was destroyed by fire.

One of the mills of the Boston Bedding Company, at South Natick, Mass., has been destroyed by fire.

The board of trustees of the Industrial school, New Bedford, Mass., will install a boiler and engine.

The Hennessey, Maxwell & Hennessey Shoe Company, Lynn, Mass., will erect a new three-story factory.

The Celluloid Starch Company, New Haven, Conn., is to erect a three-story addition to its factory in this city.

The Temple Stuart Chair Company has purchased land at Baldwinville, Mass., and will erect a furniture factory.

The Boston Manufacturing Company, Waltham, Mass., has placed contract for the erection of a new boiler house.

The Rathburn Knitting Company, Woonsocket, R. I., is to double the capacity of its plant by a big addition.

C. W. Dean & Co., have broken ground for a large shoe factory at Natick, Mass. Over 200 people will be employed.

The Dwight Manufacturing Company, making sheetings, etc., of Chicopee, Mass., contemplates enlarging its plant.

The town of Blue Hill, Me., is contemplating installing a waterworks system, including gasolene engine pumping plant.

H. Mintell and Carl P. Rhode, both of Providence, R. I., are to equip a plant for the manufacture of glazed paper.

An addition will be made to present plant of the Providence (R. I.) Braid Company, and a new three-story mill erected.

The New England Moral Reform Society will erect a new hospital with laundry and boiler house at Jamaica Plain, Mass.

The Worcester (Mass.) Cold Storage and Warehouse Company is to expend $26,000 for a large addition to its present plant.

W. L. Jones, 50 Francesca avenue, West Somerville, Mass., is in the market for a three-horsepower marine gasolene engine.

The large ice plant on Swains Pond avenue, Melrose, Mass., owned by Miss Orrietta Towner, destroyed by fire. Loss, $30,000.

The J. D. Bergen Company, of Meriden, Conn., is not to establish a branch plant in St. Louis, as mentioned in a previous issue.

The Harvard Knitting Mills, Wakefield, Mass., has purchased land on which a three-story mill will be erected near its present plant.

The National Fiber Board Company is building a new factory at Buxton, Me., and will install 500- to 600-horsepower waterwheels.

Buffumville village, near Oxford, Mass., has been purchased by J. Stansfield, of Amsterdam, N. Y., who will erect a large woolen felt mill there.

The city of New Britain, Conn., is drawing plans for additions to the high school. Space is to be used for boiler room and manual training purposes.

Hubbard-Jopson Manufacturing Company, Meriden, Conn., with a capital stock of $20,000, will equip a shop for the manufacture of wood and metal novelties.

The Russell Falls Paper Company, Russell, Mass., has taken over a building formerly occupied by the Russell Brick and Tile Company, and will manufacture paper.

The Galpin-Griffen Manufacturing Company, Woodbury, Conn., has been incorporated for $50,000 and will engage in the manufacture of wooden and metal articles.

The Standard Woven Fabric Company has been organized at Worcester, Mass., and proposes to erect a plant to manufacture and deal in belting, hose and woven fabrics.

MIDDLE STATES

The Kleine Optical Company, Chicago, Ill., will erect a new factory.

Escanaba, Mich., has voted $30,000 bonds for a municipal gas plant.

James S. Miller will build an electric-light plant at Sumneytown, Penn.

Vincentown, N. J., will install an electric generator for light purposes.

The mill of Frederick Kellar, Mannsville, N. Y., burned. Loss, $10,000.

The Standard Oil Company, Cleveland, Ohio, will build a new boiler house.

The Ideal Cocoa and Chocolate Company, Lititz, Penn., will enlarge its plant.

The Pooley Furniture Company, Philadelphia, Penn., is building an addition.

The village of Port Chester, N. Y., will build a $100,000 sewage-disposal plant.

Fire partly destroyed the paper-box factory of Owens & Traeger, Hoboken, N. J.

The Lakeside Paper Company will soon let contracts for a new plant at Neenah, Wis.

The Howard Demountable Rim Company, Trenton, N. J., is building a new factory.

The National Biscuit Company is considering the erection of a plant at Niagara Falls, N. Y.

W. E. Dolts & Co., Philadelphia, Penn., will build a three-story brick distillery. Cost, $7500.

The Dean Elcetric Company, of Elyria, Ohio, is having a large addition added to its plant.

The Cleveland & Pittsburg Railroad, Cleveland, Ohio, is to build a complete coal-handling plant.

The plant of the Blairsville (Penn.) Enameling Company was partly destroyed by fire. Loss, $25,000.

The Mohawk Silk Fiber Company, of Fultonville, N. Y., will locate its factory at Kingston, N. Y.

The Katonah Lighting Company, Katonah, N. Y., will spend $45,000 extending and improving its plant.

The Quaker City Rubber Company, Philadelphia, Penn., will build a two-story addition to cost $9000.

The Allegheny Steel Company, of Pittsburg, will install another open-hearth furnace and additional soaking pits.

The Syracuse Lighting Company, Syracuse, N. Y., is planning improvements to its plant and extension of mains.

The Struthers Furnace Company is soon to construct a dry-cleaning gas plant at its furnaces in Struthers, Ohio.

The tar-paper plant of the Stowell Manufacturing Company, Jersey City, N. J., was partly destroyed by fire.

The Scranton (Penn.) Lace Curtain Company is erecting an addition and will also build a new boiler house.

J. Bernhard, manufacturer of bar fixtures at East Buffalo, N. Y., will erect a four-story woodworking factory.

The Badger Chemical Company, of Waukesha, Wis., will build a turpentine plant equipped with 12 retorts.

John Owen & Son, yarn manufacturers and wool carders, Jefferson, Wis., will, it is said, rebuild mill recently burned.

Bunkard & Rivard, of Turtle Lake, Wis., have secured the installation of a pea-canning factory to cost $40,000.

The Defiance Paper Company, Niagara Falls, N. Y., has drawn plans for doubling the capacity of its present plant.

The Bullock Baking Company has purchased property at Albany, N. Y., and will erect a $20,000 bakery on same.

A special aldermanic committee is investigating the advisability of Schenectady, N. Y., building a municipal lighting plant.

The St. Lawrence Dairy Products Company, Watertown, N. Y., is erecting a plant in Watertown to manufacture butter.

At Greenville, Ohio, Aaron Eller & Son have purchased a site on Euclid avenue for the erection of an artificial ice plant.

Power plant of the St. Croix Power Company, Apple River Falls, Wis., has been wrecked by an explosion. Loss, $500,000.

The garbage reduction plant, operated by the Wilmington (Del.) Sanitary Company, was destroyed by fire. Loss, about $40,000.

The Bostal Brothers, proprietors of a brewery, at Bucyrus, Ohio, will soon begin the erection of a large artificial ice plant.

Fire destroyed the plant of Chas. I. Tagliabue Manufacturing Company, Brooklyn, N. Y., makers of thermometers and barometers.

The Manhattan Soap Company will erect a 16-story building on property at Thirty-first and Thirty-second streets and Tenth avenue, New York city.

Denton & Waterbury Company, of Whiteboro, N. Y., has purchased eight acres at that point and will erect a planing mill and establish a lumber yard.

Fire destroyed the machine and cabinet department of the Ohio Valley Furniture Company's plant at Gallipolis, Ohio. Loss, estimated at $100,000.

Curtice Brothers Company, Rochester, N. Y., manufacturing preserves, are planning an addition to its canning factory at a cost of approximately $25,000.

Power equipment will be required for the 14-story hotel to be erected for the Pennsylvania Hotel Company, at Penn avenue and Seventh street, Pittsburg, Penn.

The Storandt Manufacturing Company, making soda-water fountains, has purchased property on Lyell avenue, Rochester, N. Y., and is erecting a factory building.

The Electric Storage Battery Company has awarded a contract for the building of a six-story addition to its plant at Nineteenth street and Allegheny avenue, Philadelphia.

Power equipment will be required for the 12-story hotel to be erected for J. M. Henderson, at Euclid avenue and East Fourteenth street, Cleveland, Ohio. Architect A. C. Wolf is preparing the plans.

The Zeroze Manufacturing Company, Cleveland, Ohio, recently organized with $400,000 capital, has opened an office in the Rockefeller building. Is looking for site on which to erect a plant for manufacturing tin cans, etc.

Proposals will be received until 1 p.m., May 15, at the Watervliet Arsenal, Watervleit, N. Y., for furnishing steel, hardware, oils, etc., during the year ending June 30, 1912. Lieut.-Col. W. W. Gibson, commanding officer.

The Wolfgram Marble Company, of Port Clinton, Ohio, will build a plant as soon as a location has been decided upon. Artificial marble and cement products will be manufactured. F. S. Culver, of Port Clinton, is the president.

Proposals will be received by Lieut.-Colonel F. E. Hobbs, Rock Island Arsenal, Rock Island, Ill., until 10 a.m., May 8, for materials and supplies for year ending June 30, 1912, including hardware, leather, steel, iron, oils, chemicals, etc.

The Isthmian Canal Commission, Washington, D. C., will receive bids until 10:30 a.m., May 10, for material and supplies for the year ending June 30, 1912, including steel rails, frogs, switches, tieplates, track bolts, nut locks, nuts, pipe, wire rope, babbitt metal, wire, etc.

SOUTHERN STATES

A new 300,000-gallon pump will be installed in the city waterworks, Waycross, Ga.

The Perfection Mattress Company, Birmingham, Ala., will locate a branch factory in Mobile.

The Jacksonville (Fla.) Electric Company has commenced work on a new $500,000 power house.

H. Lindenberg, New Orleans, La., is erecting a large new shoe factory at 2256 North Claiborne avenue.

The Duncan Cotton Mills, Greenville, S. C., has awarded contract for the construction of a $1,000,000 mill.

The Clayton Linen Mills, Greenville, S. C., has been organized with $200,000 capital by R. I. McDavid, Robert L. Stanton, etc.

WEST OF THE MISSISSIPPI

The city of Central Point, Ore., will install a new sewer system.

The city of Glendale, Wash., will install a new waterworks system.

The city of Trinidad, Wash., will install a new waterworks system.

The Hartley (Iowa) Creamery Company will build a modern creamery.

Bonds have been voted at Milo, Iowa, for a municipal gas-lighting plant.

The city of Anaheim, Cal., will install a municipal eletcric-lighting plant.

Waterville, Kan., voted $13,000 bonds for electric-light plant and waterworks.

G. H. Webb, of Seymour, Iowa, is considering the erection of an ice-cream factory.

The Inland Empire Company, Metolius, Ore., will install new pumping equipment.

The Big Basin Lumber Company, Klamath Falls, Ore., will build a new planing mill.

The Farmers' Co-Operative Creamery Company, at Garner, Iowa, will erect an addition.

The Alfalfa Products Company, of Superior, Neb., will erect an alfalfa meal mill.

The Turner Oil Company, operating at Coalinga, Cal., will install a new boiler plant.

The Carthage Fuel Company, San Antonio, New Mexico, will install new boiler equipment.

The Randolph Fruit Company, Chula Vista, Cal., is building an addition to its packing plant.

The Granger (Wash.) Brick and Tile Works is planning to double the capacity of its plant.

The Independence Canning Company, of Independence, Iowa, will erect a three-story cannery.

Wing & Campbell, Eugene, Ore., are planning to install a cold-storage plant in their building.

The National Briquetting Company, of Kenmare, N. D., is planning to put in a complete plant.

The Gardiner Lumber Mill Company, Gardiner, Ore., is planning to make improvements in its plant.

The city of Burley, Ida., is planning to install a new waterworks system. Estimated cost, $45,000.

Thomas D. Petch, Medford, Ore., is contemplating the erection of a gas plant at Roseburg, Ore.

A franchise has been granted C. B. Hersey Company to install an electric-light plant at Langford, S. D.

The city of Mountainhome, Idaho, has voted bonds for $35,000 for the installation of a waterworks system.

The Eddyville (Iowa) Roller Mill, recently burned, will be rebuilt as a feed mill and cement-block factory.

The Temescal Water Company, Corona, Cal., is planning to make improvements and additions in its system.

The Porterville North Eastern Railroad, Porterville, Cal., is having plans prepared for a new packing house.

A. Beilstein, of Toppenish, Wash., is at the head of a company to erect an artificial ice and cold-storage plant.

The Union Oil Company, Los Angeles, Cal., will build a new pumping station on its oil property near Whittier.

Bottling plant of the Hamm Brewing Company, St. Paul, Minn., was partly destroyed by fire. Loss, $100,000.

The Builders Brick Company, Seattle, Wash., is having plans prepared for a three-story addition to its plant.

The Bell Brothers Piano Company, Lawrence, Kas., will locate in Muncie, Ind., where a new plant will be erected.

Harriet E. Wright, Gordon (near Tacoma), Wash., is planning to install a pumping plant on property in this section.

W. M. Costley and L. S. Thompson, Phœnix, Ariz., are planning to establish a broom factory in this section.

The city of Bellingham, Wash., is planning to make extensions in its pumping system. H. A. Whitney is city engineer.

The Consolidated Gas and Electric Company, San Diego, Cal., will make additions and improvements in its gas plant.

George Brinson, Council, Idaho, will build a factory in this vicinity for the manufacture of cement and brick products.

The American Fish and Oyster Company, San Francisco, Cal., has taken out a permit to build a new three-story building.

The Pacific Power and Light Company, Portland, Ore., is planning to build a 3000-kilowatt power plant on Hood river.

The Helmback Truck Company, Puyallup, Wash., manufacturer of wheelbarrows, trucks, etc., will remove its plant to Olympia.

The Pacific Gas and Electric Company, San Francisco, Cal., will make improvements and extensions in its gas system at Fresno.

The city of Phœnix, Ariz., will install a new sewer system to cost $200,000. Olmsted & Gillelen, engineers, Los Angeles, Cal.

M. E. Mozengo and W. H. Carr, of Clarion, Iowa, have purchased the electric-light plant and will make extensive improvements.

A franchise has been granted to the Park Dam Power Company, of Eldora, Iowa, to install a $10,000 light and power plant.

The Balfour-Guthrie Company, Portland, Ore., will build a large cement plant at Bellingham, Wash. Estimated cost, $1,500,000.

A. Olinger, Everett, Wash., is planning to build an addition to his woodworking shop and will install new planing-mill machinery.

S. G. Addington, Council, Idaho, is at the head of a company which will build a cement and brick-manufacturing plant in this section.

J. J. Newell, North Anderson street, Los Angeles, Cal., has taken out a permit to erect a new laundry plant. It will be fully equipped.

The sawmill and shingle mill of the Elbe Lumber and Shingle Company, Elbe, near Tacoma, Wash., was destroyed by fire. Loss, $100,000.

Power-plant equipment will be required in the 10-story office building to be erected by the H. W. Corbett estate, Portland, Ore. Cost, $650,000.

The Pacific Telephone and Telegraph Company, San Francisco, Cal., will build a three-story substation at Hollywood, near Los Angeles, Cal.

P. S. Venable, Redondo Beach, Cal., is planning to install a rock-crushing plant in this vicinity. A. B. Steel, Redondo Beach, will be manager.

The Ventura Mill and Lumber Company, Ventura, Cal., will build a new cabinet and carpenter shop. Woodworking machinery will be required.

The Booth Fisheries Company, now located at 207 Fifth street north, Minneapolis, Minn., is planning to build a new $500,000 cold-storage plant.

The Douglas County Irrigation Company, Wenatchee, Wash., will install a large pumping plant on 10,000 acres in the Jamison Lake district.

Libby, McNeil & Libby, Chicago, Ill., food products, have purchased property near Selma, Cal., and will build a large peach-canning factory.

Amen Moore, Oswego, Ore., is at the head of a company which will build a large cement plant in this vicinity. About $500,000 will be expended.

The oil-pumping plant of the Spokane, Portland & Seattle Railroad, at Lamont, Wash., was destroyed by fire. It will be immediately rebuilt.

Geo. H. Tully and M. P. Barnes, Quincy, Cal., are at the head of a company which is planning to build a series of power plants on the Feather river.

The plant of the North Washington Condensed Milk Company, Newberg, Ore., was destroyed by fire; considerable machinery was damaged. Loss, $15,000.

The Veterans' Home, Olympia, Wash., will build a new power plant to cost about $35,000. J. W. Bullard, architect, Tacoma, is in charge of this work.

F. S. Fling and C. F. Chiles, of St. Paul, Minn., have organized the Mahjor Cast Stone Company, and will erect a cement-block factory at McLaughlin, S. D.

The Valhalla Orchard Company, Wenatchee, Wash., will make improvements in its irrigation system to cost about $15,000. A new pumping plant will be installed.

M. W. Fockler, Winona, Wash., has purchased property in this section and is planning to install a power plant, to be used in supplying neighboring communities.

Power-plant equipment will be required in the new hotel building which will be erected at Los Angeles, Cal., by the Consolidated Realty Company. Estimated cost, $1,000,000.

The board of commissioners, Los Angeles, Cal., has requested an appropriation of $3500 for the purchase of rock-crushing machinery. The supply committee has the matter in charge.

The Municipal Light and Power Company has been incorporated at San Francisco, Cal., by Rudolph Spreckels, Claus Spreckels and P. S. Scales, with a capital stock of $1,000,000.

Power-plant equipment will be required in the new seven-story hotel which is contemplated at Los Angeles, Cal., by the Birnbaun Investment Company. It is planned to build two such structures.

The Golden State Laundry Company, San Pedro (Los Angeles), Cal., is having plans prepared for a new laundry plant on Fourth street. It will be fully equipped with all necessary machinery.

Power-plant equipment will be required in the new office building to be erected at Salt Lake City, Utah, by P. J. Moran, president, Portland Cement Company of Utah. About $175,000 will be expended.

The Davis & Weber Counties Canal Company, Ogden, Utah, is planning to build a 5500-horsepower power plant near Riverdale. Estimated cost, $300,000. Other improvement work is contemplated.

Power-plant equipment will be required in the new 10-story building to be erected at Tacoma, Wash., by R. W. Prigmore and associates. Estimated cost, $300,000. Russell & Babcock, architects, Tacoma.

Power-plant equipment will be required in the new 10-story office building to be erected at San Francisco, Cal., by J. E. Leicessster and others. Estimated cost, $200,000. Reid Brothers, architects, San Francisco.

Power-plant equipment will be required for the new group of hospital buildings to be erected by the St. Luke's Hospital, San Francisco, Cal. Estimated cost, $1,000,000. Louis P. Hobart, architect, San Francisco.

The Sterling Telephone Company, Puyallup, Wash., has been granted a franchise to operate in the Puyallup valley. The company will at once commence the installation of a system. G. H. Judges is president of this company.

The Utah Lake Irrigation Company, Provo, Utah, has been organized by J. R. Murdock and J. W. Knight. The company owns property in Salt Lake county and is planning for extensive work. Pumping equipment will be required.

The Golden Rod Milling Company (flour), Portland, Ore., has been organized to succeed the Acme Mills Company, whose plant was recently destroyed by fire. This plant will immediately be rebuilt. A. S. Goss is president of the company.

The Coachella Valley Ice and Electric Company, Coachella, Cal., is planning to build a large ice plant in this section; an electric-lighting and power plant to supply this vicinity will also be erected. W. F. Holt is the head of this company.

The Newport Power Company, Newport, Ore., has been acquired by new interests and will be known as the Yaquima Electric Company. The power plant will be improved and new equipment installed. About $30,000 will immediately be expended.

CANADA

Port Arthur, Ont., will develop power on the Current river.

J. W. Miller, of Newcastle, N. B., will equip a $150,000 tannery there.

North Battleford, Sask., will spend $38,000 for waterworks machinery.

The Sun Brick Company will establish a $200,000 plant at Toronto.

Hamilton, Ont., is building a new municipal light and power plant.

William Drador will equip a large new planing mill at Chatham, Ont.

St. Vital, Man., will build a municipal electric railway and power house.

The Winnipeg Electric Railway Company is building a large new power house.

London, Ont., will buy new transformers for the hydro-electric power stations.

Fire destroyed the plant of the Kensington Furniture Company, Goderich, Ont.

The Manson Campbell Carriage Company, of Chatham, Ont., will extend its plant.

F. G. Bell is at the head of a company which will erect a canning plant at Grimsby, Ont.

Fire caused $25,000 damage to the plant of the Hyman Tannery Company, at London, Ont.

The city of Moosejaw is calling for tenders for a 25-horsepower gasolene traction engine.

Moosejaw, Sask., will buy 300 ⅝-inch water meters, 50 ¾-inch, 25 1-inch and 12 2-inch.

Sturgeon Falls, Ont., will spend $50,000 developing electric energy for power and lighting.

The Robertson Paint and Varnish Company, of Toronto, will locate a big new factory there.

The Moosejaw Times Printing Company will equip a complete new plant with all the latest machinery.

The Canadian Light and Power Company, of Montreal, will spend $4,000,000 developing power at Cedar Rapids.

The Quebec Railway, Light, Heat and Power Company will make important extensions to its plant and system.

Arthur Reid, superintendent of the city lighting plant, at Lethbridge, Alberta, is calling for tenders for a 1500-k.v. alternating-current generating unit and a rotary converter set.

MINING

The Nevada Wonder mine, Wonder, Nev., will install new machinery.

The Cœur d'Alene mine, Cœur d'Alene district, Idaho, will install new equipment.

The Economic Mining and Milling Company, Carrizozo, N. M., will install new machinery.

The National Mines Company, National, Nev., will increase the capacity of its mill.

The Oriole Gold Mining Company, Galice, Ore., is contemplating the erection of a milling plant.

The Montana Consolidated Mining Company, Libby, Mont., is planning to build a new stamp mill.

The Ima Consolidated Mining Company, near Salmon, Idaho, is planning to install a 10-ton concentrating mill.

The Copper Queen Mining Company, Douglas, Ariz., will build a new smelting plant in this vicinity in the near future.

The Arkansas-Arizona Copper Company, Jerome, Ariz., will make improvements in its plant and install new equipment.

The East Butte Copper Company, operating the Pittsmont mines, Butte district, Mont., is planning to install new machinery.

The Antelope Valley Gold Mining Company, operating at Rosamond, Randsburg district, Cal., will erect a cyanide plant.

The Zapote mine, Chinipas district, Chihuahua, Mex., will make improvements in its plant; cyanide equipment will be installed.

The Hartford Arizona mine, Hamberg, near Tombstone, Ariz., is planning to install a two-mile aërial tramway in the near future.

The Cœur d'Alene-Jarbidge Mining Company, operating in the Jarbidge, Nev., district, is planning to erect a five-stamp mill and cyanide plant.

The Hydro-Electric Company, operating the French Hill group, Placerville, Eldorado county, Cal., is contemplating the erection of a large stamp mill.

Business Items

The plant of the Charles Greiner Company, New Haven, Conn., manufacturer of riveting machines, wire-straightening, cutting and forming machines, was destroyed by fire on April 8. Arrangements have been made for a continuance of operations at once.

The Standard Woven Fabric Company, Worcester, Mass., has been organized and incorporated under the laws of Massachusetts, with a capital of $400,000, and has purchased the business of the Multiple Woven Hose and Rubber Company. The officers are George D. Moore, president; A. H. Burdick, treasurer, and Thomas J. Daley, secretary and clerk. Mr. Moore was formerly secretary of the Multiple Woven Hose and Rubber Company, and Mr. Burdick was purchasing agent of the General Electric Company.

The Hooper-Falkenau Engineering Company has recently been formed to take over the business of George K. Hooper, designer and organizer of industrial plants. Mr. Hooper's experience covers a period of 25 years of work, including the designing and planning of a wide variety of industrial projects. Mr. Falkenau, in joining forces with Mr. Hooper, withdraws from the Falkenau-Sinclair Machine Company, of Philadelphia, of which he has been president for a number of years. His best known work is in the field of designing and manufacturing special machinery. The new firm will carry on the same class of work that each member has done previously and is prepared to furnish engineering advice and special designs of all kinds for industrial plants.

Trade Catalogs

Nicholson File Company, Providence, R. I. Catalog. Files. Illustrated, 92 pages, 8x10½ inches, paper.

Rockwell Furnace Company, 26 Cortlandt street, New York. Bulletin No. 28. Simplex melting furnace. Illustrated.

Narragansett Machine Company, Providence, R. I. Pamphlet. Standard steel lockers. Illustrated, 9 pages, 6x9 inches.

The Rowbottom Machine Company, Waterville, Conn. Circular. No. 26-E ball-bearing disk grinder with exhauster. Illustrated.

Templeton, Kenly & Co., Ltd., Chicago, Ill. Catalog No. 13. Simplex car and track jacks. Illustrated, 28 pages, 3½x6 inches, paper.

Precision Die Casting Company, Syracuse, N. Y. Pamphlet. Die-cast machine parts and engine bearings. Illustrated, 4 pages, 7x9 inches.

S. W. Card Manufacturing Company, Mansfield, Mass. Catalog No. 26. Taps, dies, screw plates. Illustrated, 156 pages, 5x7 inches, paper.

Climax Hoist Company, 1753-55 North Howard street, Philadelphia, Penn. Catalog C. Hoists, trolleys, cranes. Illustrated, 32 pages, 3½x6 inches, paper.

South Bend Machine Tool Company, South Bend, Ind. Catalog No. 41. Foot and power screw-cutting engine lathes. Illustrated, 32 pages, 6x9 inches, paper.

Forthcoming Meetings

Southern Hardware Jobbers Association and American Hardware Manufacturers Association; joint convention, San Antonio, Texas, St. Anthony hotel, April 26, 27 and 28, 1911.

National Machine Tool Builders' Association, spring meeting, May 18-19, 1911, Hotel Marlborough-Blenheim, Atlantic City. Chas. E. Hildreth, secretary, Worcester, Mass.

American Foundrymen's Association, annual convention, Pittsburg, Penn., May 23 to 26, 1911. Richard Moldenke, secretary, Watchung, N. J.

American Society of Mechanical Engineers, spring meeting, Pittsburg, Penn., May 30 to June 2, 1911. Secretary, C. W. Rice, 29 West 39th St., New York City.

The Institute of Operating Engineers. Regular meeting second Thursday of each month, Engineering Societies building, New York City. M. W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Philadelphia Foundrymen's Association; meetings first Wednesday of each month, Manufacturers Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday noon for ensuing week's issue. Answers addressed to our care, 505 Pearl Street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G.Smith, Columbia, Pa.

Tools, dies, jigs, etc., built to order. W. C. Munz, Erie, Penn.

Special machinery developed and manufactured. Tompkins Bros. Co., Troy, N. Y.

"Engineering Data." For shop, drafting room and office. Box 677, Amer. Machinist.

We buy or pay royalty for good patented machine or tool. Box 282, Amer. Machinist.

Wanted—Work for screw machines and gear cutter. Box 775, American Machinist.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Punches and dies, jigs and fixtures, light and medium weight machinery, etc., built to order. Taylor-Shantz Co., Rochester, N. Y.

Wanted—Machine and press work; tools, dies, jigs and machines built to order. The G. M. Diehl Machine Works, Wabash, Ind.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Wanted—Work for gear cutters, hand turrets, milling machines, etc.; fine work in quantities. The Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Gear cutting, spur, bevel spiral wanted; parts machinery and complete machines built. The T. C. M. Manufacturing Co., 46 Lawrence St., Newark, N. J.

Light and medium weight machinery and small parts in quantities; also screw machine and punch press work, tools, jigs, dies and high grade machinery. The Elgin Tool Works, Elgin, Ill.

Are you looking for an exclusive agent on your goods for New York, Brooklyn and Long Island? We are in our new building open to do business. Edwin B. Stimpson Company, 68-70 Franklin Ave., Brooklyn, N. Y.

Large English firm of machine tool importers having showrooms and offices in Great Britain, France, Germany, Italy, India and Japan is wanting good agencies for machine tools of all kinds. Box 189, Amer. Mach.

$2.00 will buy castings and all material for nearly designed automatic steam engine of 1/16 horsepower; engine has rotary valve with adjustment for wear; blueprints and instruction sheets 25 cents. Elgin Wheel & Engine Co., Dept. B.

Welding by oxy-acetylene process; special attention given to repairs of machinery and castings of all kinds; large experience in difficult experimental work; structural shapes welded together; write for particulars. Krajewski-Pesant Co., 54 Beard St., Brooklyn, N. Y.

Proposals for ordnance supplies. Watervliet Arsenal, Watervliet, N. Y., April 15, 1911. Sealed proposals, in triplicate, will be received until 1 p.m., May 15, 1911, for furnishing steel, hardware, forage, fuel, oils, etc., during year ending June 30, 1912; information furnished on application. Lieut-Col. W. W. Gibson, Commanding.

A German mechanical engineer, who will take a trip during August and September through France and Germany, in which countries he has a personal acquaintance with many manufacturing concerns would like to obtain a few commissions representing American manufacturers in the above countries. Box 750, American Machinist.

An inventor of several compressed air and steam specialties for which there is a growing demand with no competition, would like to arrange with reliable concern to manufacture same on royalty; this would mean a clean and profitable manufacturing business to parties who would do as they agree. Address "Steamair," American Machinist.

A high grade foundry in the Middle West is seeking the manufacture of special machines, engines or other articles requiring heavy castings; would consider space privilege with party looking for foundry connection. What have you? We have well equipped foundry, modern building and unequalled shipping familities. Box 745, Amer. Mach.

Watervliet Arsenal, Watervliet, N. Y., April 1, 1911. Sealed proposals, in duplicate, subject to the conditions of the sale, will be received at this office until 10 o'clock a.m., May 1, 1911, for the purchase of condemned ordnance stores. Catalogs giving quantities, condition, etc., can be had on application to the Commanding Officer, Watervliet Arsenal, Watervliet, N. Y.

Representative; German manufacturing company, Europe's largest and leading concern in pneumatic tools, having developed these lines to a perfectness, exceeded by no other manufacturer in the world, and enabling it to meet every competition, is contemplating extending its sale to the United States, and solicits correspondence from American engineering or manufacturing concerns of first rank, having a large selling organization, for which the pneumatic tool line is adapted; a representative of the European company, will arrive in New York about the middle of April. Address Box "P. L.," American Machinist.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Partner with moderate capital in a growing business; no incumbrance; in a manufacturing center in Canada; must possess a thorough knowledge of jig designing, and how to produce small interchangeable parts requiring accurate assembling for mechanics' tools; also gear cutting and building of marine motors. Box 739, AM., MACH.

CALIFORNIA

Wanted—Foreman for machine shop doing general machine shop work in Los Angeles, Cal.; state age, experience, former employers, salary wanted and qualifications for such a position; man with western experience only desired. Box 709, AMERICAN MACHINIST.

ILLINOIS

Wanted—Draftsman; one familiar with multiple stage blowers preferred. Houston Manufacturing Co., Rockford, Ill.

MASSACHUSETTS

Wanted—Department foreman for 25 or 30 men; location, central Massachusetts. Box 734, AMERICAN MACHINIST.

Wanted—Experienced man to take entire charge of gage department in large factory; must have executive ability; we want the best; no other need apply. Box B, AM. MA.

Foreman wanted for forge and tool hardening department of a plant manufacturing small tools and special machinery; new equipment and increasing business should make this a desirable position for the right man. Box 740, AMERICAN MACHINIST.

Wanted—Designing draftsman with electrical experience, preferably with a technical education, for a permanent position with the General Electric Company, Lynn, Mass. Apply stating age, education, experience and salary expected by addressing Chief Draftsman, General Electric Co., Lynn, Mass.

MICHIGAN

Wanted—A factory superintendent for a steel stamping plant that is turning out a line of metal fixtures, novelties and hardware specialties; first class equipment for dies as well as production; growing business; splendid opportunity for a man who knows and can produce; attractive salary, and to the right man an interest if agreeable. Box 753, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Draftsmen, toolmakers and first class machinists. Address Saurer Motor Co., Plainfield, N. J.

Wanted—An experienced air compressor designer; must be well recommended; state experience and salary. Box 748, AMER. MACH.

Gear cutting foreman, with general experience; must know something about figures, and be familiar with spiral, worm and bevel gears; state age, experience and some idea of salary expected. Address "Gear Cutting," Box 690, AMERICAN MACHINIST.

NEW YORK

Wanted—A first class designer for special printing machinery; only those who can furnish the best of references need apply. Box 566, AMERICAN MACHINIST.

Wanted—High grade mechanical superintendent for machinery manufacturing plant; must be first class mechanic and manufacturer; state experience; $5000 or more to right man. Box 737, AMERICAN MACHINIST.

Wanted—First class hand screw machine foreman; job also includes two Brown & Sharpe, and one large size Gridley automatic; man must be resourceful and first class handler of help; good pay to right party. Address Box 730, AMERICAN MACHINIST.

Enlargement of works calls for tool and model makers of exceptional skill; apply by letter, giving experience and qualifications fully; state wages and inclose names and addresses of all former employers for reference. Box 758, AMERICAN MACHINIST.

Wanted—A young man who can write good, understandable English without frills or attempts at "literathoor," and who has had shop experience; one who has successfully handled mechanical advertising copy preferred. Box 712, AMERICAN MACHINIST.

Wanted—Foreman for tin shop on high-grade automobile work; state age, experience, name, employers for the past five years, give salary expected and reason for making a change; all replies will be treated confidentially on request. Address "Tin Shop," AM. M.

Wanted—Assistant tool room man; one who has had experience in tool room of shop under the Taylor system in tool making, grinding and checking; good opportunity for bright young man; state fully experience, references, age and salary expected. Box 752, AMERICAN MACHINIST.

Wanted—One assistant shop superintendent at $7.04 per diem and one assistant shop superintendent at $6 per diem; a competitive examination will be held April 24, 1911, for the purpose of filling the above positions. For further information address "Commandant," Navy Yard, Brooklyn, N. Y.

Wanted—Assistant foreman with technical and practical knowledge of the carbonizing, hardening and treatment of steel; must be familiar with uptodate methods and capable of handling men; state age, experience and salary expected; all replies treated confidentially. Address "Carbonizing," AM. MACH.

Wanted—Superintendent with good executive ability and education; to have full charge of plant manufacturing high grade machine tools; must be competent to direct designing of new machine tools and special fixtures for accurately producing duplicate parts in quantities; state fully experience, education, age and salary. Box 726, AMERICAN MACHINIST.

Wanted—Time study man and speed boss experienced in shop under the Taylor system; must be thorough machinist, capable analyzing and standardizing operations and taking time studies, and able later to hold position as speed boss; state fully experience, references, age and salary expected to start; good future opportunity for right man. Box 751, AMERICAN MACHINIST.

Wanted—Foreman machinist, a steady, industrious man to take charge machine shop, making brass automobile parts; employ 20 machine hands and three toolmakers; man must be capable of estimating tool and labor cost from blueprints; in replying state experience and salary expected; a good opening for right man. Address "Central," Box 695, AMERICAN MACHINIST.

OHIO

Wanted—First class machinists, toolmakers, die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood and metal patternmakers, brass polishers, buffers, finishers, millwrights, hammermen and blacksmiths, who wish to increase their opportunities, to register with the free Employment Department of the National Metal Trades Association, New England Building, Cleveland, Ohio.

PENNSYLVANIA

Designer and draftsman for general machinery; location within 100 miles of New York City. Box 693, AMERICAN MACHINIST.

Wanted—Man with experience in constructing rotary machines for forming tin and sheet steel of the lighter gages; should be capable of handling men; give particulars of experience, salary, etc. Box 736, AMER. MACH.

Wanted—Young man thoroughly trained in uptodate machine shop practice to assist foreman in increasing production and inspecting work produced; man familiar with piece or premium methods of engine shops preferred. Address Drawer "E," Erie, Penn.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

RHODE ISLAND

Wanted—Fifty tool designers; experienced competent men in the design of jigs, fixtures, punches and dies and other special tools used in the manufacture of high grade machine parts on an interchangeable basis; apply by letter stating age, experience and salary required, as well as the date when you would be able to start if application was accepted. The Taft-Peirce Manufacturing Company, Woonsocket, R. I.

WISCONSIN

Wanted—A good draftsman, experienced and well educated, preferably thoroughly familiar with all features of design upon cream separators; steady work and good prospects; give references, state experience and wages expected. Address P. O. Box 1590-A, Milwaukee, Wis.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Works manager or general superintendent; American of 40, with 26 years' shop experience, including last 11 years as superintendent; wide range of general manufacturing, large and small work; a high grade, modern executive of proven ability with A-1 references, showing successful record in charge of large plants; present salary $4500. Box 759, AMERICAN MACHINIST.

ILLINOIS

Manager or superintendent, capable of taking entire charge of a manufacturing plant, desires to make a change; experience with and references from three of the largest, best known plants in America. Box 754, AMERICAN MACHINIST.

MASSACHUSETTS

Machine designer, five years' shop and 10 years' drafting experience on automatic, special and shoe machinery. F. W. Meyer, Gen. Del'y, Northampton, Mass.

MINNESOTA

Position of trust in a large manufacturing concern; am now general manager of a large gasolene engine plant; 12 years' experience. Age 35. Box 749, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, 30, with 15 years' practical and technical experience, desires position as salesman for Europe in fine automatic machinery and sub-press dies. Box 757, AMERICAN MACHINIST.

Designing draftsman wishes change; 12 years' experience on machine tools, special machinery, electrical work, jigs and fixtures, experimental work, etc.; position off the drafting board preferred; good education; best references. Box 760, AMER. MACHINIST.

NEW YORK

Blacksmith, machine forgings, experienced high speed tool dresser. Box 735, AM. MA.

A-1 tool and automatic draftsman desires position. S. E. Boynton, 210 Railroad Ave., Brooklyn, N. Y.

First class mechanical engineer and designer is open for engagement; is practical mechanic; has good reference as to inventive ability, honesty and experience. Box 756, AMERICAN MACHINIST.

Superintendent, expert mechanic, sheet metal drawing, automatic machine designing, tool and die works, position as mechanical superintendent or general foreman. Box 761, AMERICAN MACHINIST.

Toolmaker or machinist; young man well trained to close work on tools and jigs; can work on bench and all tools; three years' experience as all-around man. Box 755, AMERICAN MACHINIST.

Mechanical engineer and draftsman (29), married, technical education, nine years' practical experience, desires position in designing, construction, or sales department in New York city or vicinity. Box 738, AMER. MACHINIST.

Wanted—A position by a foreman; can handle a screw machine department successfully; can design tools and lay out cams from A to Z for accurate work; understand all makes of automatic machines; 18 years' experience in this line. Box 742, AM. MACH.

Young mechanical man, age 29, technically trained with 11 years' practical experience as apprentice, machinist, foreman, draftsman, designer, checker and at present assistant chief draftsman for large manufacturing concern, desires position as chief draftsman or factory superintendent; thoroughly uptodate in matters pertaining to shop standards and efficiency. Box 741, AMERICAN MACHINIST.

OHIO

Practical mechanic who can demonstrate in any department in the manufacture of automobiles, considerable experience on gears, wishes position as superintendent or chief inspector; at present employed. Box 715, AM. M.

PENNSYLVANIA

Expert all-around mechanic, age 35, thoroughly experienced on experimental, model work and scientific instruments, desires change; would consider any location. Box 743, AMERICAN MACHINIST.

FOR SALE

Old established plant manufacturing high grade line of equipment, for sale; in operation thirty-seven years; now running; price right. Wm. H. H., 1818 Holland St., Erie, Penn.

For Sale—One story and basement brick machine shop, forty by one hundred feet, fully equipped for light work, now running, located in growing town within fifty miles of Philadelphia, on two trunk lines; or will combine with party having good light mechanical line; references exchanged; no agents or triflers. Box 747, AMERICAN MACHINIST.

For Sale—A three-fourths interest or the whole of a well established and successful manufacturing business, with well equipped machine shop, foundry and accessories; established lines of manufacture and doing good business; located in the healthiest, and one of the most rapidly growing industrial centers in the Piedmont section of the South; principal owner is growing old and desires to retire; investment upward of $200,000; don't write unless you mean business. Box 746, AMERICAN MACHINIST.

Talks With Our Readers

By The Sales Manager

A man usually values a thing at just about what it costs him.

The more we pay for anything the more anxious are we to get full value for our money.

This is brought to mind by the thoroughness with which our foreign readers make use of the AMERICAN MACHINIST.

They pay from $7.25 to $10 per year for the English Edition of the AMERICAN MACHINIST and MASCHINENBAU, published weekly.

But it is worth more than that to them.

* * *

Look in the department "Discussion of the Previous Question" and note the number of contributions from abroad.

Then read the extracts from a few of the letters we have received showing how the Selling Section is studied by them.

We have taken your paper chiefly because of the advertisements that it contains, since we are always alert in that direction.

Nähmaschinenfabrik Karlsruhe
(Sewing Machine Factory)
vorm. Haid & Neu
Karlsruhe i. Baden, Germany.

* * *

On the one part your Zeitschrift für praktischen Maschinenbau is a very powerful advertising organ; on the other part it contains a large number of good kinks which are worth knowing, not only for single operations, but also for repetition manufacture.

Markranstädter Automobilfabrik
(Automobile Factory)
Hugo Ruppe
Markranstädt bei Leipzig, Germany.

We would inform you that although, self-evidently, we very highly prize the suggestions and kinks in your journal, the advertisements are of especial use to us in the selection of articles to purchase.

Konekauppa-Osakeyhtiö Aatra
Helsingfors, Finland.

* * *

Your journal offers to me not only a valuable guide to sources of supply of the latest machines and tools, but also, by its discussions on practical working methods, often gives suggestions for the improvement of our equipment.

F. Schimmel
Techn. Direktor der Maschinenfabrik
"Rototype"
("Rototype" Machine Works)
Nancy, France.

* * *

We would say that we do not build machinery ourselves, and your journal serves us as a reference list for the machines we need in our work.

Ver. Freiburger Uhrenfabriken A.-G.
(Clock or Watch Factory)
Freiburg i. Schl.

* * *

We can inform you with satisfaction that we read your honored journal with great interest, and that the contents of the same, especially the advertising section, afford us many very useful suggestions.

Fabrique
Nationale d'Armes de Guerre
(Military Arms Factory)
Herstal-Lez-Liége, Belgium.

* * *

I would inform you that I am extraordinarily pleased with your valued paper. Its rich contents satisfies the most exacting requirements. Your letters from practice are contributions of highest value, and I have already utilized some of them in my shops. The advertising department has already served me by providing a good reference list for my needed purchases.

Eugen Hercz
Maschinenfabrik und Eisengiesserei
(Machine Shop and Foundry)
Miskolcz, Hungary.

* * *

The articles in your journal are very suggestive, and even the advertising part is to a certain extent a work of reference for the most modern manufacturers.

Ingenieur Eugen Braun
(Engineer)
St. Petersburg, Russia.

* * *

Your journal gives me many suggestions, and for me, who am often confronted with questions regarding improvements, it is an indispensable reference book, which I could no longer do without.

Oswald Forst, Mech. Werkstätte
(Machine Shop)
Solingen, Germany.

Not only the editorial part, interesting in every number, but also the fullness of the advertisements has already done me frequent service in finding new and good sources of supply.

Werkzeugfabrik Heinrich Bink
(Tool Works)
Vienna, Austria.

* * *

Your journal, because of its text department, which contains very many practical, useful suggestions, and especially also because of its teeming advertising department, is always read eagerly by our employees. We have already obtained from the paper many kinks that have been of advantage to us in manufacture.

Apparatebauanstalt Fischer
(Machinery or Instrument Works)
Frankfurt a. M.-Oberrad, Germany.

* * *

The advertising section of your honored journal presents to every man not only an interesting, but also an instructive, part of the latest trade literature in word and picture. In the editorial department of your valued paper, practical men, especially shop leaders, find multifold instruction concerning new things, often confirming their own observations and experiences and thus frequently inciting them to further study.

Maschinenbau A.-G. vorm. Breitfeld
(Machine Shop)
Danek & Co.,
Prag-Karolinenthal, Bohemia, Austria.

* * *

At the present time we are engaged in enlarging our plant, so that we are in a position to purchase new machines, etc. For this purpose your excellent journal has given us many suggestions.

Rudolf Ley, Maschinenfabrik
(Machine Shop)
Arnstadt in Thür., Germany.

* * *

If you are not using these pages each week to get money making and saving ideas, kinks and suggestions that will help you in your work, you are not getting all your money's worth—

You are missing a vital opportunity.

* * *

Only reliable products can be continuously advertised.